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NOTES ON TREMELLOGASTER SURINAMENSIS

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(WITH PLATES 22 AND 23)

Tremellogaster surinamensis was first collected in Surinam by Dr. Gerold Stahel during an expedition up the Saramacca River. This material was sent to Ed. Fischer, who described it (**2**) as belonging to a new genus and species, tentatively assigned to the Lycoperdaceae. Two years after the species was first collected, the writer in 1924 again discovered it at Koreai Creek, a short distance above Bartica on the Essequibo River in British Guiana. Peculiarly enough, the species was growing under almost the same conditions reported for the original material, namely at the foot of a hill bordering a swamp on moist sandy soil near a decaying log. The extension of range and the ecological conditions, however, are of minor consideration in this paper, since its main purpose is to throw additional light on the structure, development, and classification of this rare and unusual fungus.

Because of the maturity of the material available to him for study, Fischer was unable to make out the development of the species, especially in regard to the gleba. In the present studies a similar handicap exists, for while the material is considerably less mature than that studied by Fischer, nevertheless stages from the development of the primordium to the immature gleba are lacking and make impossible an accurate determination of the development of the fruiting body. On this account, only inferences can be made as to the origin of certain structures, based on the evidence present in the more advanced but still immature material at hand.

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As stated by Fischer, the peridium appears to be formed by the differentiation of the outer layer of the hyphal strands on which the primordium was produced. This outer layer, in the peridium of the more advanced stages, has become differentiated into three zones. The outer one is characterized by a thin layer of dark, heavy-walled, twisted, sclerotioid hyphae (PLATE 23, FIG. 7) which gradually gives way internally to thin-walled, hyaline hyphae that run almost parallel to the surface. The middle and most conspicuous zone is brownish and gelatinous, divided into irregular polygonal areas by plates of non-gelatinous tissue. The inner or third zone is composed of hyaline mycelium that intertwines and also runs approximately parallel to the surface of the fruiting body. The mycelium of the inner zone is further characterized by the irregular transverse thickenings of the cell walls, as stated by Fischer.

Because of the fact that the peridium of mature material appeared to be distinct from the gleba, Fischer was led to believe that the two tissue systems developed separately—one from the outer layer of the mycelial strand, the other from the inner layer or medulla. There is additional evidence for this assumption, for if the hyphae of the middle zone of the peridium, next to the inner and outer zones, are studied it can be seen from the orientation of the numerous clamp connections (PLATE 23, FIG. 11) that the middle zone is formed by centrifugal growth from the inner zone and centripetal growth from the outer one. The inner polygonal areas of the gelatinous zone appear to have been formed first, since they are larger and the hyphae are more scattered, while in the outer part of the zone the irregular gelatinous areas are smaller and the hyphae more closely packed. Presumably the hyphae have not secreted as much gelatinous material and are therefore less distantly separated. The reduction in size of the polygonal "fields" is clearly shown on the upper part of the sectioned fruiting body shown in figure 1 of plate 22. These are apparently formed from the outer layer of the peridium as is evidenced by loculi found in this tissue where the cavities are filled with a mucilaginous material which strongly suggests that found in the middle zone.

The gleba in mature specimens is quite distinct and is free from

the inner layer of the peridium. In the younger specimens, however, there is a loose connection between the two tissues brought about by a few scattered hyphae from the inner layer of the peridium penetrating into the gleba. In the even earlier stages of the development of the gleba it appears that there was a loose mass of rather stout mycelium, (3.1)–4.5–5.4 μ diam., the elements of which were loosely branched and had anastomosed rather frequently. Clamp connections were also formed in relative abundance (PLATE 22, FIG. 4). These hyphae, in material available for study, appear to have been compressed by the growth of the numerous fertile areas to which they have given rise. The majority of the hyphae have lost their protoplasmic content, but here and there may be found a few that still retain their cytoplasm and which are readily stained by the cotton blue in the lacto-phenol mounting medium.

The fertile areas do not appear to have arisen in the manner stated by Fischer (**2**) for the Clathraceae and by Cunningham (**1**) for *Lycoperdon depressum*. Evidence of the ingrowth of tramal plates or special tissue is absent. Instead, the ends of the branches of the coarse hyphae become richly and irregularly short-branched in definite areas and there aggregate to form the dense subhymenial layer of the individual fertile mass. More than one of the coarse hyphae is involved in this process so that the fertile area is surrounded by hyphae of the former loose mass, but these hyphae have become inconspicuous through compression and it is only by crushing and separating the material that they can be made out.

The subhymenial layer is 5 to 9 μ thick and composed of very densely aggregated elements. At maturity, however, the original hyphae with the clamp connections have practically disappeared, as have also the basidia. As a result, the subhymenial layer in the dried and mature gleba becomes loosened and somewhat separated. During the process, the walls of the subhymenial elements have become somewhat thicker and sparsely though conspicuously warty-spinulose (PLATE 22, FIGS. 2, 3), and thus modified appear to be comparable in function but not in development with the capillitium of *Lycoperdon*. For lack of a better term these structures may be called pseudo-capillitia.

The basidia, forming an hymenial layer of approximately 20 μ in thickness, arise directly from the much branched subhymenial elements. They are extremely transparent and are stained only with considerable difficulty. Unless the sections are carefully crushed so as to separate the densely aggregated basidia, an individual basidium is extremely difficult to find. When isolated, however, they are found to be clavate or nearly cylindrical with the apical end slightly larger than the basal end, and are 20–22 $\times$ 5–5.5 μ. Each basidium (PLATE 22, FIG. 5) bears four sterigmata on which the spores are produced. The basidiospores are at first hyaline and sparsely echinulate, but with maturity become enlarged, spherical, brown, and more densely echinulate. Occasionally under the higher powers of the microscope, the spores may be seen to be pedicillate from the persisting hyaline remnants of the sterigmata.

DISCUSSION

From the foregoing account, it appears that Fischer was thoroughly justified in not considering this genus as belonging to the Clathraceae since the absence of tramal plates in the development of the gleba would preclude such an affinity. On the other hand, this same character would also exclude this form from the Lycoperdaceae in which he tentatively placed it. In addition, the lack of a true capillitium and of large glebal chambers would seem to place the species in another family. In figure 4, plate 22, it is clear that the hyphae of the glebal fundament have given rise locally to hyphal knots which are comparable to those observed by Rabinowitsch (**3**) for *Scleroderma bovista*. It therefore seems preferable to consider *Tremellogaster surinamensis* a member of the Sclerodermataceae, rather than of the Lycoperdaceae.

DESCRIPTION

In view of the more complete data available, it seems desirable to add to the original description of the species as follows:

TREMELLOGASTER SURINAMENSIS Ed. Fischer.

Fruiting body 4–7 cm. diam., "Clay Color" [1] below, becoming "Bistre" above, "Russet" to "Deep Mars Brown" in dried

[1] Ridgeway, R. Color Standards and Color Nomenclature. Washington, D. C., 1912.

material, the surface coarsely flattened-tuberculate, more conspicuously rounded-tuberculate above. Mycelial strands "Clay Color." Peridium up to 1 cm. thick, with an outer zone of thick-walled, colored sclerotioid hyphae bordered internally by thin-walled, hyaline to subhyaline hyphae that run approximately parallel with the surface of the fruiting body; a middle conspicuous brownish gelatinous zone, reticulately divided by lighter colored non-gelatinous tissue; and a white inner zone of non-gelatinous tissue that consists of hyphae that intertwine and run more or less parallel, the cell walls wrinkled by transverse thickenings. The gleba, at first "Warm Buff," becoming "Hays Brown" and powdery. Pseudocapillitium of varying length, 2.5–4 μ diam., much branched, hyaline, sparsely warty-spinulose. The basidia forming a palisade-like hymenium, clavate, tapering towards the base, 20–22 $\times$ 5–5.5 μ, with four short sterigmata. The basidiospores globose, echinulate, dark brown, 5–6 μ diam., occasionally minutely and inconspicuously pedicellate.

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EXPLANATION OF PLATES

PLATE 22

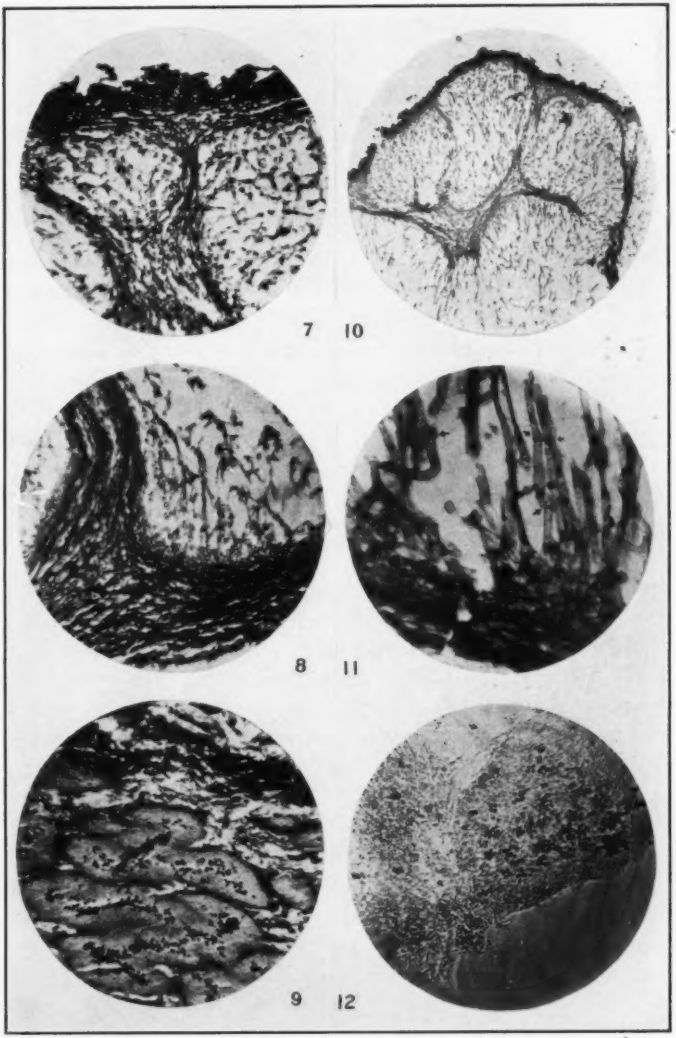
All drawings are made with the aid of a camera lucida.

Fig. 1. Fruiting bodies of *Tremellogaster surinamensis.* Note the greater development of the peridium at the summit of the longitudinally cut fruiting body at the right. The outer and smaller irregular gelatinous areas appear to have been formed after the inner and larger ones by addition from the outer zone of the peridium. From freshly collected specimens; Figs. 2–3. Pseudocapillitium from the mature gleba. At *ba* may be seen a remnant of a basidium. Approx. $\times$ 800; Fig. 4. The much branched and anastomosing hyphae of the glebal fundament. Above and at the right, the branches become irregularly and frequently branched to form the subhymenial layer, which is partly indicated by dotted lines, as is the hymenial layer. The dark portions of the hyphae indicate where the protoplasm still persists. Note the abundance of clamp connections. From material soaked in dilute sodium hydroxide and crushed under the coverglass in lactophenol. Approx. $\times$ 800; Fig. 5. A clavate basidium bearing four immature spores. Approx. $\times$ 800; Fig. 6. Basidiospores from mature material. Approx. $\times$ 1850.

PLATE 23

All photographs, except fig. 12, are made from sections cut 10 μ thick and stained with Delafield's *Haematoxylon*.

Fig. 7. Photograph to show the thin outer peridium composed of deeply stained, thick-walled, sclerotioid hyphae, and a portion of the middle zone that is divided by a plate of non-gelatinous tissue; Fig. 8. The inner zone of the peridium composed of parallel strands of hyphae, from which has arisen a plate of non-gelatinous tissue. The non-gelatinous plates that arise from the inner zone of the peridium are mostly denser than those from the outer zone; Fig. 9. A portion of the gleba next to the inner layer of the peridium. Note that the basidia form a dense palisade-like layer that is only slightly stained. The subhymenial layer is scarcely visible; Fig. 10. Low power of the peridium illustrating the formation of the smaller gelatinous areas in the outer portion of the middle zone. It is these smaller areas that give the fruiting body its coarsely tuberculate appearance; Fig. 11. Hyphae arising from the inner zone of the peridium. The arrows point to clamp connections which, as can easily be seen, indicate that the hyphae have grown outward; Fig. 12. A portion of the gleba, showing basidiospores in fours. The arrow points to a remnant of the glebal primordium. From material in lactophenol crushed under the cover-glass.



TREMELLOGASTER SURINAMENSIS

NEW FUNGI FOUND ON THE INDIAN CORN PLANT IN ILLINOIS

G. L. Stout

(With Plate 24)

Of the sixteen new species that have been found, fourteen are associated with spots on the leaves of corn and two have been found on the stalks at or near the basal nodes. Although the pathenogenicity of none of them has been tested by inoculation methods, it seems likely that at least those found on the leaf-spots are responsible for the particular lesions with which they are associated. Of the two that occur on the stalk, *Helminthosporium zeicola* shows some indication of being a parasite, but the nature of the other species is doubtful. None of the sixteen fungi appear to be of any considerable economic importance as plant pathogens, although taken collectively they may play a minor part as such by reducing the photosynthetic area of their host. Again, it should be remembered that their appearance is usually quite late in the season and toward the end of the life of the corn plant, when they are likely to have little effect on the yield. In a study of them, however, some are found to present some very interesting mycological problems, particularly in relation to their life cycles and the possible relationship between perfect and imperfect forms.

The genera and species are presented in alphabetical order. The type specimens are deposited in the herbarium of the State Natural History Survey of Illinois, at Urbana, and they are designated each by an accession number and a notation as to the place and date of collection, as may be noted in the descriptions given below.

Ascochyta Maydis n. sp.

Pycnidia located in a tiny patch on a large, effuse, translucent, dead area of the leaf, developed subepidermally, opening either epiphyllously or hypophyllously by a minutely papillate ostiole, dark-brown, membranous, their walls composed of a pseudo-

parenchyma, lenticular, 75–150 μ in diameter; ostiole rounded, 7.5–15 μ across, the ostiolar papillum of smaller cells and appearing darker than the wall of the pycnidial body. Spores two-celled, hyaline, long-ellipsoid to fusoid, rarely slightly constricted at the septum, 11–18 $\times$ 3–4.5 μ. (PLATE 24, FIG. 1.)

On leaves of *Zea Mays* L.

Type specimen: Macomb, McDonough County, Illinois. October 11, 1926. Nat. Hist. Surv. Acc. No. *19688.*

Percy, Randolph County, Illinois. November 9, 1927. Nat. Hist. Surv. Acc. No. *21204.* In this specimen, the spores were somewhat broader and shorter than in the type, measuring up to 10–16 $\times$ 5 μ. They were distinctly septate and slightly constricted at the septum, and they emerged in cirri from the pycnidia when the latter were mounted in water on the microscope slide.

Only the two collections have been made.

Ascochyta Zeae n. sp.

Spots at first ellipsoid, becoming elongated and somewhat irregular, sometimes confluent, the leaf veins tending to bound them laterally, their margins brown and well defined to fading, their interiors becoming tan-cinereous. Pycnidia moderately abundant, developed subepidermally, sometimes in rows between the microscopic leaf veins, opening either epiphyllously or hypophyllously, often through the stomata, by a minutely papillate ostiole, dark-brown, membranous, their walls composed of an indistinct pseudoparenchyma, lenticular, 55–160 μ in diameter; ostiole rounded, 6.5–18 μ across, the ostiolar papillum appearing darker than the wall of the pycnidial body. Spores obscurely uniseptate, the septum often apparently lacking, hyaline, oblong-ellipsoid to somewhat irregular, rarely constricted at the septum, 8.5–13.5 $\times$ 3–4.5 μ. (PLATE 24, FIG. 2.)

On leaves of *Zea Mays* L.

Type specimen: Mount Carmel, Wabash County, Illinois. November 9, 1926. Nat. Hist. Surv. Acc. No. *19581.* Collected only once.

Two other species of *Ascochyta* have been described as occurring on corn, from which the two species above may be distinguished as follows.

On stalks
Spores 6–8 × 1.5–2 μ ..... *A. zeicola*
On leaves
Spores 8.5–13.5 × 3–4.5 μ ..... *A. Zeae*
Spores 11–18 × 3–4.5 μ ..... *A. Maydis*
Spores 18 × 7.5 μ ..... *A. zeina*

Coniothyrium Zeae n. sp.

Spots at first ellipsoid, becoming elongated and irregular, sometimes confluent, the leaf veins tending to bound them laterally, at first tan colored, their margins brown and well marked to somewhat fading, their interior becoming lighter. Pycnidia located in the mesophyll, opening by a minutely papillate ostiole, brown, membranous, composed of a pseudoparenchyma, globose, 130–150 μ in diameter; ostiole rounded, 12–30 μ across, the ostiolar papillum appearing darker than the pycnidial wall. Spores one-celled, brown-olivaceous, their walls dark and well marked, long-ellipsoid, often presenting one nearly flattened and one curved side, 8.5–13.5 × 4.4–6.6 μ. (PLATE 24, FIG. 3.)

On leaves of *Zea Mays* L.

Type specimen: Putnam, Putnam County, Illinois. October 6, 1926. Nat. Hist. Surv. Acc. No. *19686.*

Casey, Clark County, Illinois. October 24, 1927. Nat. Hist. Surv. Acc. No. *21159.* In this specimen, the pycnidia were somewhat larger than in the type, measuring up to 230 μ across, but the spores were entirely typical.

Only the two collections have been made, but these were in widely separated parts of the State.

Although its spores have the color and form of *Sphaeropsis* spores, this fungus is placed in *Coniothyrium* for two reasons: (1) the spores are too small for a *Sphaeropsis;* (2) there are no conspicuous conidiophores.

This fungus differs from *Sphaeropsis ambigua* Mont., also found on corn, by its smaller spores, those of *S. ambigua* measuring 15 × 5 μ.

Helminthosporium zeicola n. sp.

Caulicolous; occurring in a dark-olivaceous effuse patch at and below the first node above the uppermost roots. Sporophores superficial, chocolate-brown to black-olivaceous, arising singly or in groups of two to four, usually about 6.5 μ in diameter but ranging from 5.5 to 7.7 μ wide by 160 to more than 300 μ long, up

to 15 or more septate at intervals of 8.5–45 μ, the spores produced at or between the septa at the apices of well marked geniculations, the first spore produced at 75–165 μ or more from the base and successive spores at intervals of 6.5–45 μ, the basal end of the basal cell of the sporophore swollen as into a bulb usually about twice the diameter of the base of the sporophore. Spores concolorous with the sporophores to dilute-olivaceous, narrow-ellipsoid to subcylindrical, widest near the middle or basal part, often tapering considerably to the rounded ends, straight to slightly curved, rarely irregular or abruptly bent, three to eleven septate, rarely constricted at the septa, the hilum external and sometimes obscure, 33–115 $\times$ 10–17 μ, germination in tap water by end cells within several hours. (PLATE 24, FIG. 4.)

On stalk of *Zea Mays* L.

Type specimen: Dixon, Lee County, Illinois. September 27, 1926. Nat. Hist. Surv. Acc. No. *19884.*

Eichorn, Hardin County, Illinois. October 21, 1926. Nat. Hist. Surv. Acc. No. *20180.* This specimen was associated on the culm with an irregular, water-soaked spot which had a definite to fading brownish margin, the spot occurring at and extending below the stalk node. The sporophores were much longer than in the type, measuring up to more than 500 μ, and they had more septa. Bipolar germination of the spores occurred in tap water within several hours.

Mount Carroll, Carroll County, Illinois. September 27, 1926. Nat. Hist. Surv. Acc. No. *20182.* This specimen was associated with a very irregular, grayish-black spot at the stalk node, with the mycelium in places extending into the pith and darkening the tissue. Bipolar germination of the spores occurred in tap water within several hours.

Shelbyville, Shelby County, Illinois. November 16, 1926. Nat. Hist. Surv. Acc. No. *20181.* This specimen was associated with a dark-gray, irregular spot on the stalk at the topmost root node and extending out on a prop root, which it appeared to have rotted. The sporophores were sometimes of greater basal diameter than in the type and somewhat longer, measuring up to 8.5 μ in diameter by more than 400 μ long. Bipolar germination of the spores occurred in tap water within several hours.

As may be noted by the four collections indicated, this fungus has been found in widely scattered parts of the State.

Although this fungus seems to closely fit the *Helminthosporium* stage of *Ophiobolus heterostrophus* Drechsler, the author hesitates to consider it identical without knowledge of any perfect stage of it. It will be noted that *H. zeicola* has always been found on the stalk nodes, while Drechsler's fungus is associated with a leaf spot, and he makes no mention of its appearance on culms, although the latter may not necessarily be of any great significance. Until it may be proved that the two fungi are identical, the author is setting his fungus aside under the name *Helminthosporium zeicola*.

Leptosphaeria Maydis n. sp.

Foliicolous; spots at first ellipsoid, becoming elongated and somewhat irregular, sometimes confluent, the leaf veins tending to bound them laterally, at first grayish-tan-colored, their margins brownish and well marked to fading, their interior becoming cinereous. Perithecia not abundant, located in the mesophyll, often in rows between the microscopic leaf veins, opening either epiphyllously or hypophyllously, sometimes through the stomata by a minutely papillate ostiole, brown, membranous, composed of a pseudoparenchyma, globose, 50–150 μ in diameter; ostiole rounded, 12–24 μ across, the ostiolar papillum appearing darker than the perithecial body. Asci subcylindrical, straight to curved, short-stiped, their walls hyaline and somewhat thickened at the apex, 50–66 $\times$ 8.5–11 μ. Paraphyses obscure, hyaline, filamentous, exceeding the mature asci. Spores eight per ascus, often with one at each end of the ascus and the other six arranged biseriately, greenish-yellow to olivaceous, four-celled, narrow-elliptical to narrow-fusiform, straight to curved, very slightly constricted at the septa, 15–22 $\times$ 4–5.5 μ.

On leaves of *Zea Mays* L.

Type specimen: Vandalia, Fayette County, Illinois. November 6, 1926. Nat. Hist. Surv. Acc. No. *19423*.

Shelbyville, Shelby County, Illinois. November 16, 1926. Nat. Hist. Surv. Acc. No. *19669*. In this specimen, when pressure was applied to the perithecium, the hymenium emerged *en masse* with the asci and paraphyses remaining *in situ*. The paraphyses were definitely observed to exceed the mature asci in length. The asci were larger than in the type, measuring 45–84 $\times$ 11.5–13.5 μ.

Moline, Rock Island County, Illinois. October 8, 1926. Nat. Hist. Surv. Acc. No. *19716*. Here the paraphyses measured up

to 100 μ long by 13 μ wide. Associated in the same spot with this specimen and appearing on the same slide was *Septoria Zeae*.

Streator, La Salle County, Illinois. September 23, 1926. Nat. Hist. Surv. Acc. No. *19671*. In this specimen the spores were wider than in the type, measuring up to 22 × 6.5 μ. The asci were larger than in the type, measuring up to 80 × 13.5 μ.

This was associated on the same spot with *Septoria Zeae*, the latter showing on the same slide with the *Leptosphaeria*. On the same leaf also was *Phyllosticta Zeae*.

Elgin, Kane County, Illinois. September 24, 1926. Nat. Hist. Surv. Acc. No. *19725*. Here the spores were longer than in the type, measuring up to 24.2 × 5.5 μ. The asci were larger than in the type, measuring up to 77 × 13.2 μ.

This was associated on the same spot with *Septoria Zeae*, the latter showing on the same slide.

Mount Carmel, Wabash County, Illinois. October 6, 1927. Nat. Hist. Surv. Acc. No. *21223*.

This fungus has been collected six times, in the above noted six counties in widely scattered parts of the State.

The frequent and intimate association of *Leptosphaeria Maydis* and *Septoria Zeae* suggests that these two may be the perfect and imperfect forms of the same fungus.

Leptosphaeria variiseptata n. sp.

Foliicolous; spots at first ellipsoid, becoming elongated and somewhat irregular, sometimes confluent, the leaf veins tending to bound them laterally, at first tan-colored, their margins brownish to fading, their interior finally becoming cinereous. Perithecia located in the mesophyll, opening either epiphyllously or hypophyllously but not amphiphyllously by a minutely papillate ostiole, dusky brown, membranous, composed of a pseudoparenchyma, globose, 90–150 μ in diameter; ostiole rounded, up to 26.5 μ across, the ostiolar papillum appearing darker than the perithecial body. Asci subcylindrical to subclavate, straight to curved, sessile to very short-stiped, the wall hyaline and slightly thickened at the apex, 55–95 × 11–13.5 μ. Paraphyses hyaline, filamentous, about 2 μ in diameter, exceeding the mature asci in length. Spores eight per ascus, arranged biseriately, olivaceous, four- to six-celled, the number of septa differing within a single ascus, suboblong to long-fusoid, widest at the second or third cell from the tip and tapering to the rounded ends, sometimes

slightly curved, hardly constricted at the septa, 18.5–24.5 × 4.5–6.5 μ.

On leaves of *Zea Mays* L.

Type specimen: Roscoe, Winnebago County, Illinois. September 25, 1926. Nat. Hist. Surv. Acc. No. *19726*.

Carmi, White County, Illinois. November 10, 1926. Nat. Hist. Surv. Acc. No. *19727*.

These two collections were made in widely separated counties, in the northern and southern parts of the State.

This fungus differs from the preceding by its larger asci and spores and by the variable septation of the latter.

Leptosphaeria Zeae n. sp.

Foliicolous; spots at first ellipsoid, becoming elongated and irregular, sometimes confluent, the leaf veins tending to bound them laterally, at first tan-colored, their margins brownish to fading, their interior finally becoming cinereous. Perithecia located in the mesophyll, sometimes in rows between the microscopic leaf veins, opening either epiphyllously or hypophyllously, often through the stomata, by a minutely papillate ostiole, brown, membranous, composed of a pseudoparenchyma, globose, 60–130 μ in diameter; ostiole rounded, 18–29 μ across, the ostiolar papillum appearing darker than the perithecial body. Asci subcylindrical, straight to curved, sessile to short-stiped, the wall hyaline and somewhat thickened at the apex with an apparent pore inside in immature asci, 50–66 × 10–13.5 μ. Paraphyses obscure, hyaline, filamentous. Spores eight per ascus, usually with one spore at each end of the ascus and the other six arranged biseriately, brown-olivaceous, three-celled, oblong with rounded ends, the basal cell slightly narrower and longer and tapering to its rounded end, slightly constricted at the septa, 13–22 × 4.5–5.5 μ. (PLATE 24, FIG. 5.)

On leaves of *Zea Mays* L.

Type specimen: Sandoval, Marion County, Illinois. November 6, 1926. Nat. Hist. Surv. Acc. No. *19421*.

Clay City, Clay County, Illinois. November 8, 1926. Nat. Hist. Surv. Acc. No. *19422*.

In this specimen, an occasional spore showed failure to develop one of the septa, resulting in a one-septate spore with an extra large (long) tip cell.

Shelbyville, Shelby County, Illinois. November 16, 1926.

Nat. Hist. Surv. Acc. No. *19661*. Here the spores were often much more deeply constricted than in the type, so that the individual cells of the spore assumed a nearly spherical form. On the slide, numerous free single cells were seen which apparently were individual cells of the spores which had readily broken apart, although their identity was not definitely proved. In one case a spore was observed with what appeared to be the tip cell in the process of breaking away at the septum.

Crab Orchard, Williamson County, Illinois. October 8, 1927. Nat. Hist. Surv. Acc. No. *21228*.

The above four collections were in counties scattered over the southern half of the State.

This species differs from the two preceding by its three-celled spores.

Leptothyrium Zeae n. sp.

Foliicolous; pycnidia hypophyllous, not gregarious but occurring in small patches, sometimes on elongate-oblong tan-colored spots which are bounded laterally by the leaf veins, subcuticular and possibly subepidermal, circular, dimidiate, dark-brown, membrano-subcarbonous, parenchymatically-reticulate, 55–225 μ in diameter, ostiole lacking. Spores one-celled, hyaline, irregularly globose, sometimes with one or more flattened sides, 8.5–13.5 μ, their walls somewhat thickened. (PLATE 24, FIG. 6.)

On leaves of *Zea Mays* L.

Type specimen: Vandalia, Fayette County, Illinois. November 6, 1926. Nat. Hist. Surv. Acc. No. *19445*.

Sullivan, Moultrie County, Illinois. November 16, 1926. Nat. Hist. Surv. Acc. No. *19670*. This specimen agrees with the above in all characters except the size of the spores, which measure 4.5–8.5 μ. These seemed to be immature.

Belleview, Calhoun County, Illinois. November 7, 1927, occurring on the same spot and preserved on the same slide with *Mycosphaerella zeicola*. Nat. Hist. Surv. Acc. No. *21154*.

The three collections all came from the south central part of the State.

Mycosphaerella zeicola n. sp.

Spots elongate-ellipsoid, becoming somewhat irregular, the leaf veins tending to bound them laterally, their margins brownish to

fading, their interior grayish-tan-colored. Perithecia hardly gregarious but occurring in patches, located in the mesophyll, sometimes in rows between the microscopic leaf veins, opening hypophyllously, sometimes through the stomata. by a minutely papillate ostiole, brown, membranous, composed of a pseudoparenchyma, globose or flattened-globose, 70–110 μ in diameter; ostiole rounded, 14–28 μ across, the ostiolar papillum appearing darker than the perithecial body. Asci cylindrical, straight to curved, tapering at base to a short stipe, their walls hyaline and somewhat thickened at the apex, 33–55 $\times$ 11–14 μ. Spores eight per ascus, arranged biseriately, hyaline to greenish, two-celled, subellipsoid to subfusoid, the tip cell largest and tapering to a rounded apex, the other cell narrower, usually shorter, and tapering to a rounded end, markedly constricted at the septa, 11–18 $\times$ 4–6 μ. (PLATE 24, FIG. 7.)

On *Zea Mays* L.

Type specimen: Vandalia, Fayette County, Illinois. November 6, 1926. Nat. Hist. Surv. Acc. No. *13803*.

Belleview, Calhoun County, Illinois. November 7, 1927. Nat. Hist. Surv. Acc. No. *21154*. Asci longer than in the type and measuring up to 66 $\times$ 14 μ. On the same slide and on the same spot with this specimen was *Leptothyrium Zeae*.

Bruce, Moultrie County, Illinois. October 21, 1927. Nat. Hist. Surv. Acc. No. *21194*. The pycnidia opened epiphyllously in this specimen.

Champaign, Champaign County, Illinois. September 23, 1927. Nat. Hist. Surv. Acc. No. *21151*. In this specimen the spots were definite and elongated, the perithecia were slightly larger than in the type, measuring up to 135 μ across, with their diameter 2 to 3 times their depth, ostiole up to 33 μ, and the spores measuring from 3.5–6 $\times$ 11.5–17 μ. On the same slide appeared typical spores of *Septoria Zeae*.

Effingham, Effingham County, Illinois. September 20, 1927. Nat. Hist. Surv. Acc. No. *21166*. On same slide from same spot was *Phyllosticta Zeae*, of which the spores emerged in a cirrus.

Gibson City, Ford County, Illinois. October 4, 1926. Nat. Hist. Surv. Acc. No. *19697*. Perithecia measure up to 130 μ in diameter.

Harrisburg, Saline County, Illinois. October 10, 1927. Nat. Hist. Surv. Acc. No. *21212*. Perithecia epiphyllous, measuring

mostly 100–110 μ but in one instance up to 130 μ. Asci mostly typical, but occasionally measuring up to 66 $\times$ 15 μ, and, in one instance, 83 $\times$ 14 μ. Spores somewhat wider than in the type, measuring up to 6.5 μ by 19 μ long.

Mattoon, Coles County, Illinois. September 15, 1927. Nat. Hist. Surv. Acc. No. *21164*. Epiphyllous (nearer to upper surface as seen by hand lens).

Minonk, Woodford County, Illinois. September 29, 1926. Nat. Hist. Surv. Acc. No. *19685*. Spots much more definite than in the type. Perithecia epiphyllous.

McLeansboro, Hamilton County, Illinois. November 10, 1926. Nat. Hist. Surv. Acc. No. *20136*. This specimen occurred in the same spot and appeared on the same slide with *Septoria zeicola*. (See above accession number under the latter species.)

Mount Carmel, Wabash County, Illinois. October 6, 1927. Nat. Hist. Surv. Acc. No. *21222*. Typical but epiphyllous.

Riverton, Sangamon County, Illinois. October 19, 1927. Nat. Hist. Surv. Acc. No. *21216*. Asci measure up to 76 μ, and spores measure 15 $\times$ 6.5 μ.

West City, Franklin County, Illinois. November 12, 1926. Nat. Hist Surv. Acc. No. *19629*. Associated in the same spot and on the same slide with this specimen were *Septoria zeicola* and *Phyllosticta Zeae*.

In addition to the above, this fungus has been collected five other times, in five different counties, making a total of 18 collections in various parts of the southern two-thirds of the State.

Phaeocytosporella n. gen.

A genus of the tribe Phaeosporae, of the family Sphaerioidaceae, of the order Sphaeropsidales, of the Fungi Imperfecti. Stromata superficially carbonous, oblong to elongate-oblong, at times irregular in outline, sometimes confluent, becoming erumpent, loculate, all locules joined by openings at the bottom, one to several locules opening through the same ostiole, one to several beaked ostioles per stroma. Spores one-celled, brown, produced at the tips of simple sporophores which line the entire inner surface of the labyrinthine, locular, stromate structure.

Phaeocytosporella Zeae n. sp.

Caulicolous; not maculicole. Stromata numerous, gregarious, sometimes confluent, occurring in a region 50 by 7 mm., which ex-

tends lengthwise of the host stalk just above the topmost root node, oblong to narrow-elongate and often irregular in outline, developed subepidermally but at maturity becoming almost wholly erumpent, superficially carbonous, dark-brown under the microscope, in section showing a semicarbonous cortical region and a pseudoparenchymatous interior within which the pycnidial locules lie. Locules usually several per stroma, well defined though often very imperfect and formed by undulations of the stroma wall, joined together at the bottom, opening through a common ostiole; ostioles one to three or more arranged in a fairly regular row lengthwise of the stroma, in section appearing (when the locular divisions are not well defined) as though several ostioles opened from one large chamber coextensive with the stroma, beaked, the beaks 100–165 μ high by 100–125 μ wide, the openings 40–45 μ across. Spores one-celled, long-ovoid, the basal end often markedly attenuate, at maturity becoming dusky-brown, 9–15.5 $\mu \times$ 4–6 μ, borne on filamentous, simple, hyaline to dilutely-colored sporophores which measure about 20–45 $\times$ 0.75 μ.

On culm of *Zea Mays* L.

Type specimen: Mattoon, Coles County, Illinois. October 19, 1926. Nat. Hist. Surv. Acc. No. *20039*.

Collected only once.

The parasitism of this fungus is doubtful.

Phyllosticta Zeae n. sp.

Spots at first ellipsoid, becoming elongated and irregular, sometimes confluent, the leaf veins tending to bound them laterally, at first tan-colored, their margins brownish to fading, their interior finally becoming cinereous. Pycnidia located in the mesophyll, often in rows between and sometimes appressed to the microscopic leaf veins (vascular strands), opening epiphyllously or hypophyllously by a minutely-papillate ostiole, brown, membranous, composed of a pseudoparenchyma, globose or flattened-globose, 60–150 μ in diameter; ostiole rounded, 12–26 μ across, the ostiolar papillum appearing darker than the wall of the pycnidial body. Spores one-celled, hyaline, ovoid to ellipsoid, 4.5–7.5 $\times$ 2–3.5 μ. (PLATE 24, FIG. 8.)

On leaf of *Zea Mays* L.

Type specimen: Robinson, Crawford County, Illinois. November 5, 1926. Nat. Hist. Surv. Acc. No. *19359*.

Duquoin, Perry County, Illinois. October 8, 1927. Nat. Hist. Surv. Acc. No. *21196*. Spores emerged in a distinct cirrus and

seemed to be held together by a gelatinous or mucilaginous hyaline substance.

Mattoon, Coles County, Illinois. September 15, 1927. Nat. Hist. Surv. Acc. No. *21165*. On same slide from same spot was *Mycosphaerella zeicola*.

In various specimens of this species other than the type, the spores were seen to emerge from the pycnidium in a distinct cirrus.

Collected 50 times and in 43 counties widely distributed throughout the State. Probably present in all counties.

No species of this genus has been described as occurring on corn, but two species of *Phoma* have been reported from which this fungus may be distinguished as follows:

Spores cylindrical, 4–6 × 1.5–2 μ ..... *Phoma Maydis*
Spores fusoid-oblong to oblong-ellipsoid, 4.5–5.5 × 1.5 μ, pycnidia 80–100 μ ..... *Phoma zeicola*
Spores ovoid to ellipsoid, 4.5–7.5 × 2–3.5 μ, pycnidia 60–150 μ ..... *Phyllosticta Zeae*

Physalospora Zeae n. sp.

Foliicolous; perithecia located in the mesophyll, opening by a minutely-papillate ostiole, externally carbonous, but microscopically a dark reddish-brown, with a pseudoparenchymatous wall which is continuous with an inner structure of hyaline pycnosclerotial pseudoparenchyma enclosing the hymenium and from which the latter appears to arise, globose, 75–235 μ in diameter; ostiole rounded, 12–30 μ across. Asci cylindrical, straight to curved, stalked, double-walled, a tiny pore sometimes apparent at the apex, the inner wall fitting closely to the spore column, the outer wall thickened, especially at the apex, and colorless so as to be seen with difficulty except for its obscure outer boundary, 85–150 × 13–22 μ. Paraphyses obscure, hyaline, filamentous. Spores eight per ascus, arranged subbiseriately, hyaline to very dilute olivaceous, one-celled, narrow-ellipsoid, often tapering to narrow, rounded ends, sometimes presenting one flattened and one curved side, 19–25 × 6.5–8 μ. (PLATE 24, FIGS. 9–10.)

On leaves of *Zea Mays* L.

Type specimen: Vandalia, Fayette County, Illinois. November 6, 1926. Nat. Hist. Surv. Acc. No. *19883*.

On the same leaf with this specimen was *Macrophoma Zeae*, Tehon & Daniels, Nat. Hist. Surv. Acc. No. *19882*, and a pycnosclerotial form which may be described as follows: pycnosclero-

tia very abundant, densely spread over a large elongated dead area of the leaf, separate, globose, 100–225 μ in diameter, located in the mesophyll, usually adjacent to and often slightly flattened against the inner surface of the upper or lower epidermis, finally opening either epiphyllously or hypophyllously by a minutely papillate ostiole, externally carbonous, in section composed of a dark, reddish-brown, pseudoparenchymatous wall continuous with a hyaline pseudoparenchyma which fills the interior, the latter sometimes appearing to histolyze and result in the formation of what appear to be irregularly globose or angular free cells or cell fragments; ostiole rounded, about 25 μ across.

This pycnosclerotial form was again found intimately associated on the same leaf with *Macrophoma Zeae* (Hamel, Madison County, November 15, 1926. Nat. Hist. Surv. Acc. No. *19941*) and an immature ascomycete which gave evidence of being *Physalospora Zeae*, although none of its asci were found to be mature enough to furnish spores so that it might be identified with certainty.

It was possible to observe in various young perithecia of this ascomycete a pycnosclerotium-like interior within which young asci were found in various stages of development. This fact, coupled with the constant intimate association of the pycnosclerotia and perithecia in the same area on the leaf in that specimen and the pycnosclerotial character of the inner wall of the perithecia, as noted in the description of *Physalospora Zeae* above, with the accompanying association of also of the two forms (pycnosclerotia and perithecia), tends to suggest that possibly the pycnosclerotia are simply a younger stage in the development of the perithecium.

Further, the equally constant and intimate association of *Macrophoma Zeae* in both instances above might tend to suggest the *Macrophoma* as a pycnidial stage in the *Physalospora*. We, of course, do not know that the pycnidia of the *Macrophoma* and the perithecia of the *Physalospora* do not both develop through the pycnosclerotial stage.

Associated with *Macrophoma Zeae* in a specimen from Paris, Edgar County, Illinois, November 4, 1926, Nat. Hist. Surv. Acc. No. *21236*, was an ascomycete not sufficiently matured to bear

spores, but which bore all other evidence of being *Physalospora Zeae*.

Physalospora Zeae differs from *Physalospora zeicola* Ellis and Ev. by its much larger asci and by its longer but narrower spores.

Pleosphaerulina zeicola n. sp.

Spot elongate and extensive, rather irregular, more or less laterally bounded by the leaf veins, its margin brownish to fading, broad and not well defined, and its interior grayish-tan-colored. Perithecia not abundant, grouped in a tiny patch, located in the lower mesophyll, opening hypophyllously through a minutely papillate ostiole, brown, membranous, composed of a pseudoparenchyma, flattened-globose, 100–150 μ in diameter; ostiole rounded, 35–50 μ across, the ostiolar papillum appearing darker than the perithecial body and presenting the appearance of a ring when viewed from above. Asci ovate to saccate, apparently without stipe, their walls hyaline and often thickened toward one end of the ascus, 56–73 $\times$ 33–43 μ. Spores eight per ascus, hyaline, muriform, subellipsoid to suboblong, broader toward one end, transversely 3- to 5-septate and longitudinally 1- to 2-septate, often constricted at the septa, 8–15 $\times$ 26–38 μ. (PLATE 24, FIG. 11.)

On leaf of *Zea Mays* L.

Type specimen: Highland, Madison County, Illinois. October 26, 1927. Nat. Hist. Surv. Acc. No. *21182*.

Collected only once.

Associated with this form and covering the entire spot was a fungus that showed signs, by its undeveloped conidiophores and general appearance, of being an *Alternaria*, a *Macrosporium*, or a *Helminthosporium*, but it was too immature to produce spores so that it might be identified. It seems possible that this might be an imperfect condition of the *Pleosphaerulina*.

Septoria Zeae n. sp.

Spots at first ellipsoid, becoming elongated and somewhat irregular, the leaf veins tending to bound them laterally, their margins dark and well marked to fading, their interior becoming tan-cinereous. Pycnidia located in the mesophyll, opening by a minutely-papillate ostiole, brown, membranous, composed of a pseudoparenchyma, globose, 90–130 μ in diameter; ostiole rounded, 11–22 μ across, the ostiolar papillum appearing much darker than the pycnidial body. Spores often adhering in

bundles of two or more after leaving the pycnidium, at maturity usually seven- (rarely eight-) septate, sometimes slightly constricted at the septa, the cells usually longer than the width of the spore, the end cells elongate and particularly the basal cell often with attenuated color, nearly hyaline to very dilute greenish-yellow, cylindrical, tapering slightly to one or both rounded ends, straight to variously slightly curved, 25–62 × 2.5–4 μ. (PLATE 24, FIG. 13.)

On leaf of *Zea Mays* L.

Type specimen: Joliet, Will County, Illinois. September 24, 1926. Nat. Hist. Surv. Acc. No. *19673*.

Dixon, Lee County, Illinois. September 27, 1926. Nat. Hist. Surv. Acc. No. *19681*. The spores in this specimen were somewhat more constricted at the septa and larger than in the type, measuring 40–77 × 2.5–5.5 μ and ranging up to fourteen-septate in some cases.

Elgin, Kane County, Illinois. September 24, 1926. Nat. Hist. Surv. Acc. No. *19725*. Perithecia up to 150 μ in diameter, spores up to nine-septate and measuring up to 62 × 4.5 μ. This specimen was associated in the same spot and appeared on the same slide with *Leptosphaeria Maydis*, Nat. Hist. Surv. Acc. No. *19725*.

Moline, Rock Island County, Illinois. October 8, 1926. Nat. Hist. Surv. Acc. No. *19716*. Associated on same spot and slide with *Leptosphaeria Maydis*, Nat. Hist. Surv. Acc. No. *19716*.

Mount Carroll, Carroll County. September 27, 1926. Nat. Hist. Surv. Acc. No. *19682*. Spores often markedly constricted, up to ten-septate, measuring 40–66 × 3–4.5 μ. Pycnidia somewhat larger than in the type, measuring up to 150 μ in diameter.

Rockford, Winnebago County, Illinois. September 25, 1926. Nat. Hist. Surv. Acc. No. *19677*. Pycnidia measured up to 150 μ in diameter.

Stockton, Jo Daviess County, Illinois. September 27, 1926. Nat. Hist. Surv. Acc. No. *19683*. Spores often markedly constricted at the septa, up to nine-septate, measuring up to 66 × 5.5 μ.

Streator, La Salle County, Illinois. September 23, 1926. Nat. Hist. Surv. Acc. No. *20100*. Pycnidia up to 150 μ. Associated on same spot and same slide with *Leptosphaeria Maydis*,

Nat. Hist. Surv. Acc. No. *19671*. On the same host leaf was also found *Phyllosticta Zeae*.

Collected 11 times and in 11 counties scattered over the northern three-fifths of the State.

Septoria zeicola n. sp.

Spots at first ellipsoid, becoming elongated and somewhat irregular, the leaf veins tending to bound them laterally, their margins brownish to fading, their interior becoming cinereous. Pycnidia located in the mesophyll, opening either epiphyllously or hypophyllously by a minutely-papillate ostiole, brown, membranous, composed of a pseudoparenchyma, flattened-globose or lenticular, 55–135 μ in diameter; ostiole rounded, 10–15 μ across, the ostiolar papillum sometimes appearing darker than the wall of the pycnidial body. Spores one- to four- (usually three-) septate, nearly hyaline to a very dilute greenish-yellow, cylindrical, tapering to one or both rounded ends, straight to variously slightly curved, 18–38 $\times$ 2.5–3.5 μ. (PLATE 24, FIG. 14.)

On leaf of *Zea Mays* L.

Type specimen: Vandalia, Fayette County, Illinois. November 6, 1926. Nat. Hist. Surv. Acc. No. *20102*.

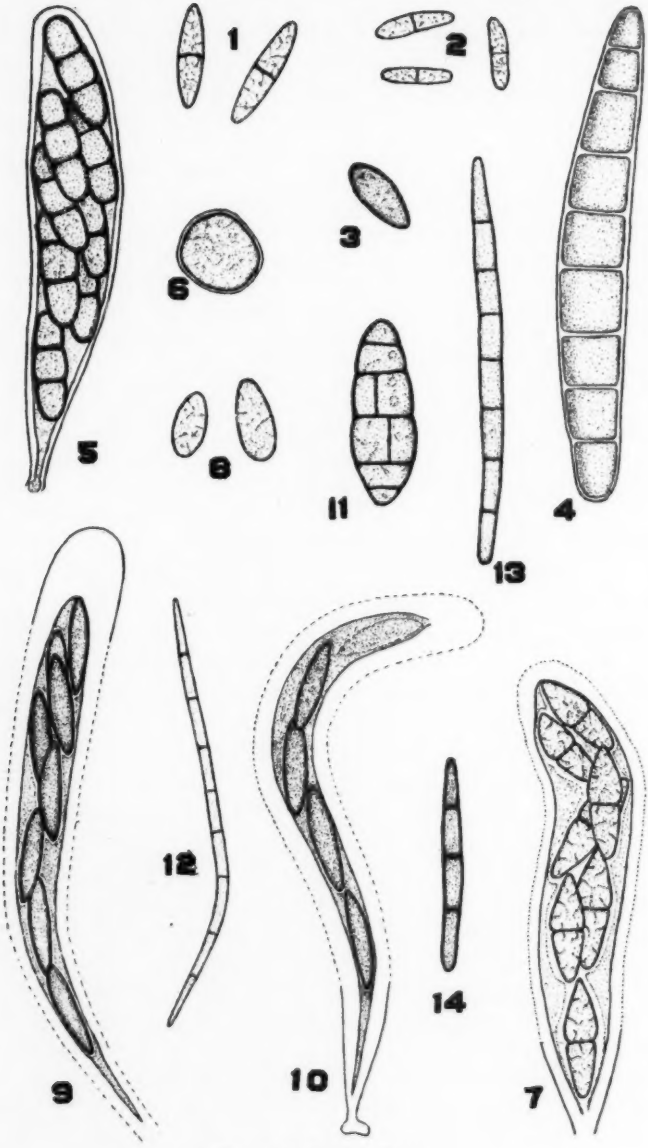
Casey, Clark County, Illinois. October 24, 1927. Nat. Hist. Surv. Acc. No. *21160*. The spores here were somewhat larger than in the type, measuring up to 46 $\times$ 3.5 μ, occasionally with as many as five septa, and sometimes very slightly constricted at the latter.

Harrisburg, Saline County, Illinois. October 10, 1927. Nat. Hist. Surv. Acc. No. *21211*. Spores measured up to 40 μ long.

McLeansboro, Hamilton County, Illinois. November 10, 1926. Nat. Hist. Surv. Acc. No. *20136*. Associated in the same spot and appearing on the same slide with this specimen were *Mycosphaerella Zeae* and *Phyllosticta Zeae*.

Mattoon, Coles County, Illinois. September 15, 1927. Nat. Hist. Surv. Acc. No. *21162*. Spores somewhat shorter than in the type, usually 20–23 μ long, but ranging from 16–27 μ, and one- to three-septate, never more than three septa seen.

Toulon, Stark County, Illinois. October 7, 1926. Nat. Hist. Surv. Acc. No. *20138*. Here the spores were somewhat larger than in the type, measuring up to 42 $\times$ 3.5 μ, and sometimes somewhat constricted at the septa.



FUNGI OF INDIAN CORN

West City, Franklin County, Illinois. November 12, 1926. Nat. Hist. Surv. Acc. No. *19629*. Associated in the same spot and on the same slide with *Mycosphaerella Zeae* and *Phyllosticta Zeae* and recorded under above number with *Mycosphaerella Zeae*.

Collected 16 times and in 16 counties well distributed over the State.

Septoria zeina n. sp.

Spot narrow-elongate, laterally bound by the leaf veins, cinereous, papery, somewhat translucent by transmitted light, without a well defined margin. Pycnidia subepidermal, opening epiphyllously by a minutely-papillate ostiole, brown, membranous, obscurely pseudoparenchymatous, flattened-globose to lenticular, 66–200 μ in diameter; ostiole rounded, 12–30 μ across, the ostiolar papillum appearing much darker than the wall of the pycnidial body. Spores filamentous, tapering at both ends to a rounded point, variously curved, obscurely many-septate but the septa (commonly eight) not always apparent, nearly hyaline or very dilute greenish-yellow, 50–90 $\times$ 2–2.5 μ, sometimes reaching 100 μ in length. (PLATE 24, FIG. 12.)

On leaf of *Zea Mays* L.

Type specimen: Taylorville, Christian County, Illinois. October 20, 1927. Nat. Hist. Surv. Acc. No. *21231*.

Septoria Maydis Schulz differs from this species and the two preceding by its smaller spores, 20–22 $\times$ 2 μ.

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EXPLANATION OF PLATE 24

1. Spores of *Ascochyta Maydis;* 2. Spores of *Ascochyta Zeae;* 3. Spore of *Coniothyrium Zeae;* 4. Spore of *Helminthosporium zeicola;* 5. Ascus and spores of *Leptosphaeria Zeae;* 6. Spore of *Leptothyrium Zeae;* 7. Ascus of *Mycosphaerella zeicola* containing seven spores (the usual number is eight); 8. Spores of *Phyllosticta Zeae;* 9. Ascus of *Physalospora Zeae* containing four perfectly formed spores and, in the upper end, one that was imperfectly formed; 11. Spore of *Pleosphaerulina zeicola;* 12. Spore of *Septoria zeina;* 13. Spore of *Septoria Zeae;* 14. Spore of *Septoria zeicola.*

ON THE RESISTANCE OF NEUROSPORA CRASSA

ANNA F. FAULL

(WITH 1 TEXT FIGURE)

The red bread-mould fungi of the *Monilia* (*Neurospora*) group, and especially *M. sitophila*, have been for many years the subjects of various lines of investigation. The recent work of B. O. Dodge (**1**, **2**, **3**, etc.) and others has demonstrated heterothallism in two of the species, established a perfect ascomycetous phase and brought out other points of interest in sexuality and hybridization in the group. Earlier work emphasized the harmful growth of these fungi in various foods, their wide distribution and occurrence in burned-over areas. Moreover, some attention has been paid to the resistance of the spores to heat and intense light. In the hope that further points on the development and resistance of *Neurospora crassa*, a species closely related to *N. sitophila*, may be of interest in this connection, the following note is presented.

The source of the material discussed here was a profuse growth of the mould which Professor W. H. Weston encountered on burned stumps of *Dichrostachys nutans* at Colonia Palmarito, Central Trinidad, Santa Clara Province, Cuba, on August 30, 1925, and from which a moulded fragment was brought back. This specimen, in March, 1928, after being kept in a herbarium packet for nearly three years, was revived in a sterile, damp chamber and from it were derived the cultures used in the following study.

GROWTH IN CULTURE

For the first gross cultures, which supplied most of the perithecial and a part of the conidial material used in the experiments and from which the pure cultures supplying the rest of the material were derived, the original fragment of *Dichrostachys* was broken into three pieces, each of which was placed in a sterile, damp chamber. Within ten days, fluffy orange-pink masses of

conidiophores and mycelium appeared covering the sticks and the sides of the chamber, even growing through the sphagnum used to keep the culture moist, while two weeks later perithecia formed in the third of these cultures and the two pure cultures on cornmeal agar taken from it. The perfect form in the gross culture when it grew on the surface near the side of the dish discharged its spores freely, but when it grew below the surface between the damp sphagnum and the glass of the container was unable to shoot out the spores which remained in dark masses after the perithecia had disintegrated. In this one culture, the perfect form developed almost entirely on the portions of the chamber least exposed to light such as the bottom of the dish and the sides turned away from the nearest window.

Pure cultures, which were examined daily for two or three months, were made from the gross cultures by transferring with a sterile needle a few conidia from them to the surface of sterile media in closed containers. Within twenty-four hours, a fine network of mycelium and a fringe of orange-pink conidiophores appeared which in succeeding days developed more abundantly, until in some cases, and especially on Sabouraud agar in test-tubes, the whole tube was filled with a cottony mass of brownish mycelium and conidiophores. When the perfect stage developed in several of the cornmeal agar cultures taken from the third gross culture, the perithecia appeared in ten days or two weeks after inoculation in brown masses on the surface of the agar and the sides of the tube where they discharged ascospores onto the opposite surfaces on which they accumulated as a black powder. In the other cultures on cornmeal agar in ten days or two weeks after inoculation instead of perithecia there appeared on the surface brown dots which proved on examination to be bulbils of many-septate contorted hyphae similar to those described by Shear and Dodge (**4**) and by Tokugawa and Emoto (**5**). These later developed into dark sclerotial masses.

Under optimum conditions, a luxuriant growth of solid masses of mycelium and conidiophores developed, even in some instances spreading far out over non-nutrient surfaces. In the case of a chance contamination of a pot of radish seedlings, conidiophores formed a red turf across the surface of the soil and the mycelium

followed bits of wood through the humus to the bottom of the pot, for conidia formed there were shed through the hole onto the table. Moreover, on bread in an evaporating dish, equally dense mats of mycelium and conidiophores formed which even grew over the non-nutrient glass to half-way across the cover of the container. But under adverse conditions on prune agar or on very wet bread, there was no appreciable growth, while under less adverse conditions, such as were encountered in cultures on nutrient agar in petri dishes where enough moisture may not have been retained, growth was scanty and, although conidia formed normally, the perithecia dried up before they could produce spores.

For study and experimental work, to supplement the gross culture material, the pure cultures on cornmeal agar in test-tubes were used because here a loose fringe of conidiophores formed, leaving a bare surface of agar for the development of perithecia and bulbils.

IDENTIFICATION

The fungus was identified by Dr. B. O. Dodge from dried material and slides as *Neurospora crassa* Shear and Dodge. The conidia, measuring 2.9–13.4 μ in diameter in this material, were often larger than is usual for the species, frequently 8.6 μ and almost as often 11.4 μ in diameter instead of the range of 6–8 μ, usually 6–7 μ, described for the type material by Shear and Dodge (**4**). But measurements of ascospores which were 20.0–33.0 $\times$ 14.3–20.0 μ, mostly 25.7 $\times$ 14.3 μ, of asci which were 140.0–170.0 $\times$ 14.0–17.0 μ, and of perithecia which were 280.0–500.0 μ in diameter were those described by Shear and Dodge (**4**) for *N. crassa*. In this material, the characteristic longitudinal markings on the ascospores were indistinct in freshly formed material but became more distinct later in both dried and mounted material.

STRUCTURE AND DEVELOPMENT

Several observations made earlier it seems worth while to emphasize here since they were also characteristic of this material. Shear and Dodge (**4**) have already demonstrated heterothallism and mentioned as characteristic the formation of bulbils in cul-

tures where only one strain is present. Also in some cases in these cultures there were abnormally large ascospores, even as large as 40 × 20 μ, described by Dodge (1) as forming where two or more nuclei instead of one are involved in cutting out the ascospore. Shear and Dodge (4) also described as characteristic of the genus germination of the spores by germ tubes from both ends, although in a few cases in this material only one of the germ tubes formed.

Three points not emphasized in the literature may be noted here, namely the time for germination of unheated ascospores, the effect of light on the imperfect stage and the nature of the "ridges" on the ascospore wall. In these tests [1] the ascospores germinated in three to four hours when finally left at room temperature except when the spores were heated and germination was delayed, in which case, as may be seen in the table, page 298, the spores required the four to five hour resting period noted by Shear and Dodge (4) or in some cases an even longer one. The imperfect stage when allowed to grow in daylight showed itself positively heliotropic, for the mats of mycelium and conidiophores would form on the sides of the containers most exposed to light and, when the dish was moved, on the side thus turned towards the light. The markings on the ascospores, moreover, seemed not to be "ridges" but lighter differentiated parts of the cell wall. The smooth outline of the spore, the absence of shadows from the "ridges" even with oblique lighting, the increase in distinctness of the lines in spores mounted for several months in balsam and, finally, the even thickness of the cell wall with no indication of "ridges" in fragments of wall broken across the lines and turned upward are proof of this (FIG. 1, *C*, *D* AND *E'*).

EXPERIMENTS ON THE GENERAL RESISTANCE OF *Neurospora crassa*

As the assumption of the thermophilic character of *Monilia* (*Neurospora*), and especially of *M. sitophila* to which *N. crassa* is very closely allied, is often found in the literature with especial emphasis on the widespread and profuse occurrence of these

[1] Since these experiments were performed this observation has been noted by B. O. Dodge in his article, "Breeding Albinistic Strains of the Monilia Bread Mold," in MYCOLOGIA, Vol. 22, No. 1, January–February, 1930.

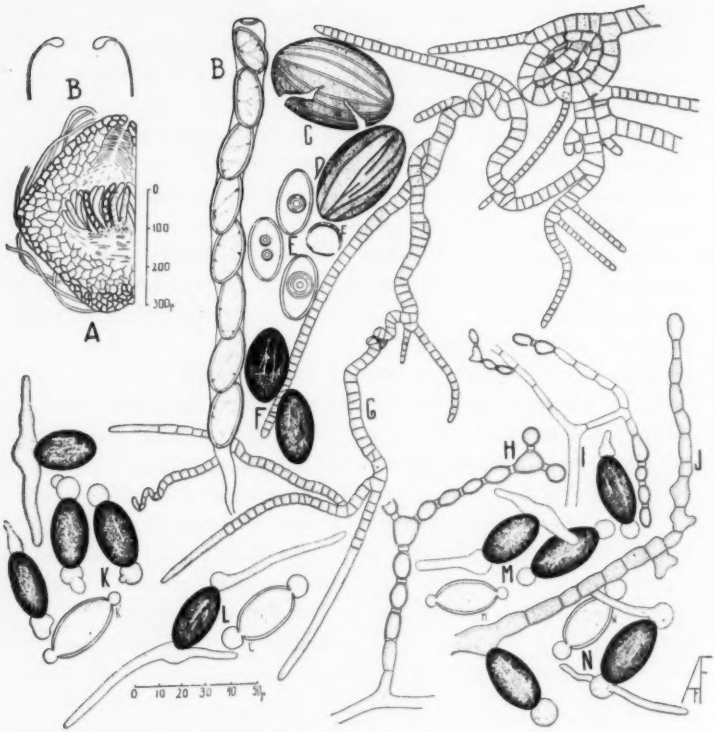

FIG. 1. These drawings of *Neurospora* (*Monilia*) *crassa* were made with a camera lucida. The magnifications given are for the printed plate, the scale of microns giving an absolute measure also.

A. Ideal median longitudinal section of half a perithecium showing the lysigenous cavity with some septate hyphae and immature asci. Section cut free hand from fresh gross culture material and mounted in Amann's medium, × 47; *B*. Mature ascus characteristic of the genus showing cylindrical, short-stipitate form, terminal pore, gelatinous apical ring and uniseriate staggered arrangement of the eight spores almost filling the ascus. From fresh, gross culture material mounted in water; *B′*. Tip of ascus described in *B* showing enlarged gelatinous apical ring in optical section; *C*. Empty ascospore coat showing characteristic longitudinal marking. From gross culture material cleared in xylol, dried on slide and mounted in balsam, × 777; *D*. Mature ascospore under oblique illumination showing markings in surface view. From same slide as *C*, × 738; *E*. Mature ascospores in optical section showing large oil drops and terminal pores in the thick wall. From gross culture material mounted in water; *E′*. Fragment of ascospore wall in cross section showing

species in burned areas and with the deduction that heat is necessary for successful growth, the question arose as to whether or not this association with heat in the tropics, in fire-swept regions or after unusual heating was the manifestation of a general resistance which might also be demonstrated under other adverse conditions such as extreme cold. An attempt, therefore, to determine (1) whether heat was necessary for development and (2) whether the fungus was equally resistant to low as well as to high temperatures was made through three sets of experiments: a first one in which the spores were heated to test the resistance to an abnormally high temperature, a second at room temperature to show the development at a moderate temperature without the introduction of heat and a third at low temperatures to discover the effect of extreme cold on the fungus.

The material used for these tests, both ascospores and conidia, was taken directly from the gross and pure cultures or, in the case of some of the ascospores, from perithecia from the same source

differentiation in composition of cell wall which in surface view gives somewhat the appearance of ridges. Included through the courtesy of Dr. B. O. Dodge and drawn from a slide lent by him; *F*. Mature ascospores in surface view showing here and there the markings that are not discernible under all conditions and the oil globules as seen through the wall. From material in Van Tieghem cell with cornmeal agar drop and drawn in place; *G*. Immature bulbil showing contorted many-septate hyphae formed at room temperature in Van Tieghem cell with cornmeal agar drop. Drawn in place; *H*. Conidiophore of normal type growing in Van Tieghem cell with cornmeal agar drop. (Conidiophores often larger and more branched); *I*. Conidiophore formed in ampule above water from spores germinating after being exposed to −79° C. for several hours. Compare normal structural and proportional features of branching, thickness of spore wall and the isthmus between every two spores with the normal conidiophore in *H*; *J*. "Conidiophore" formed in the same ampule described in *I* but under water. Compare short mycelial growth broken by cross walls into *Oidium*-like cells with unmodified walls and no connecting isthmi with normal type in *H* and *I*; *K*. Ascospores germinating normally in Van Tieghem cell with cornmeal agar drop to which they were transferred from the gross culture; *L*. Ascospores germinating normally in Van Tieghem cell with cornmeal agar drop after being exposed to −170°–−190° C. for fourteen hours; *M*. Ascospores germinating normally in Van Tieghem cell with cornmeal agar drop after being exposed to −37½° C. for one hour; *N*. Ascospores germinating normally in Van Tieghem cell with cornmeal agar drop after being exposed to −79° C. for twelve hours; *K'*, *L'*, *M'*, *N'*. Ideal optical sections through ascospores described in *K*, *L*, *M* and *N* showing contents of spores swelling out through the spores as they germinate. Except where otherwise indicated magnification is × 387.

that were kept dried in pill boxes for one or two months. Controls for both wet and dry spores for all experiments were kept at room temperature to be placed on cornmeal agar drops in Van Tieghem cells when the heated or cooled spores were returned to this temperature and placed in similar cells. All the spores were kept under observation for several days after being placed in the cells during which time notes were taken on the time elapsing before germination of the first spores and on the percentage of spores that had germinated within the succeeding few hours. The percentage of germinating spores for each Van Tieghem cell was found by adding counts up to one or three hundred of all the spores in random fields. The significant results are tabulated on page 298.

In the first experiment on high temperatures, only ascospores were used and these were heated in a temperature oven to 51½° C. for varying lengths of time. Some were put in pill boxes to be heated dry while others were transferred with a sterile needle to the surface of a cornmeal agar drop in a Van Tieghem cell to be heated in a moist condition. Some of the spores were removed to cornmeal agar drops in Van Tieghem cells at room temperature after being slowly heated to 51½° C., but the others were left at this temperature for from one to four hours. The results as given in the table on page 298 agreed with earlier notes throughout the literature that the ascospores are resistant to heat. They also showed that germination was delayed for from one to fifteen hours after the spores had been heated in a moist condition to a temperature as high as 51½° C. for an hour or more although spores heated dry to the same temperature for the same length of time showed a delay in germination of only three hours or less. The percentage of germinating spores in this test calculated at intervals of from one to eighteen hours after germination of the first spores ranged from five to ninety-four per cent.

In the second experiment, again ascospores alone were used; only in this instance they were put in Van Tieghem cells at room temperature, 27° C., without previous heating or cooling. They germinated within three or four hours, apparently the normal type of germination. The percentage of germinating spores, four to twenty-five, calculated within three or four hours after germi-

nation of the first spores, although lower than in the first experiment where the spores were allowed a much longer period of growth after germination of the first spores, is sufficient to indicate that heating is not necessary for germination of the spores.

In the third experiment, both ascospores and conidia were used, but they were subjected to four different low temperatures for varying periods. The first low temperature of 0° C. was obtained (for ascospores only) by placing them in the ice compartment of a Frigidaire cooler. To do this, the spores were placed dry in small vials or transferred to hanging drops of cornmeal agar in Van Tieghem cells which were then supported with paper in the ice pan of the cooler, covered with water and frozen. Cells and vials were removed at intervals of from several hours to eighty-two days to room temperature where the spores were kept in Van Tieghem cells for several days under observation. In every case, germination occurred within three or four hours after removal from the refrigerator. The second low temperature of $-37\frac{1}{2}$° C. was obtained for both ascospores and conidia by using a mixture of sulphuric acid and ice. The spores, dry or in water, were placed in ampules made from pieces of glass tubing eight to ten centimeters long which, when sealed, were lowered into the cooling mixture of equal volumes of *dry* scraped ice or snow and a fifteen per cent by volume dilution of sulphuric acid. Since it was hard to obtain this temperature or to keep it for more than an hour, the data were scanty, but normal germination of both ascospores and conidia was recorded in every case when the spores were returned to room temperature at the end of an hour. The third low temperature of − 79° C. was obtained for both types of spores by using solid carbon dioxide. As before, the spores, both dry and in water, were placed in ampules in the cooling substance of solid "snow" collected by holding tightly a canvas bag six inches square over the escape valve of a tilted tank of commercial liquid carbon dioxide and then packing it in an open-mouthed Dewar flask which in turn was packed in waste cotton. From time to time the ampules were removed and the spores transferred to Van Tieghem cells at room temperature where they germinated normally in almost every case. Since this temperature was easy to obtain and keep, abundant data were

gathered. The fourth low temperature of − 170° to − 190° C. was obtained for both types of spores by using liquid air. The spores, both dry and in water, were placed in ampules as before, but this time the ampules were provided with a loop at one end to which a thread was tied before they were lowered into the liquid air. At intervals of from one minute to forty-eight hours ampules of spores were removed to room temperature where they remained under observation for several days. In almost every case, the ascospores germinated normally, even when subjected to this temperature for as long as twenty-four hours when wet and as long as forty-eight hours when dry, and the dry conidia did likewise after one hour's exposure, but the conidia that had been wet were killed by as little as five minutes' exposure. Since in the third set of experiments the germination occurred as in the second at the end of three hours and with percentages of germinating spores varying from one to ninety-one, the resistance of these spores to extreme cold was demonstrated and also the fact that heating was unnecessary for germination, as found in the second experiment, was borne out.

In brief, these experiments show that *Neurospora crassa* is not a thermophile but a very resistant form with ascospores able to withstand temperatures as high as 50° C. for four hours and as low as − 170° to − 190° C. for long periods and with conidia only somewhat less resistant to extremes. They also demonstrate that for germination the ascospores do not necessarily require heating above room temperature, although Shear and Dodge (**4**) have found that heating the oven in which petri dishes of ascospores on nutrient agar have been placed to 90° C. for a short time increases the number of germinating spores and is useful in obtaining single spore cultures by the "plating out" method.

Further proof of the general hardiness of this fungus was encountered during these experiments through a chance observation on some spores that after being cooled to − 79° C. for an hour or more were left on the table in an unopened ampule for two days before growth was noticed. Although the ascospores were submerged in water where there would be little air, confined in an ampule which would restrict the supply of gases to one or two cubic centimeters and left with no food except what might be in

the water and in bits of debris that clung to them when they were placed in the ampule, they had germinated normally to produce mycelium and conidiophores. Examination showed that two types of spores had formed, first, normal but stunted conidiophores (FIG. 1, *I*) above the surface of the water and, second, *Oidia*-like spores (FIG. 1, *J*) formed beneath the water by the cutting up of the mycelium by cross walls into short cells with thin walls and no connecting isthmus in contrast to the thick walls and connecting isthmus of normal conidia (FIG. 1, *H*). That any growth should occur under these conditions and, moreover, that spores should form is still another instance of the remarkable hardiness of the *Monilia* (*Neurospora*) group and in this case of *N. crassa*.

EXPLANATION OF TABLE

Conidia used in experiments were obtained from tube cultures and transferred directly to ampules or Van Tieghem cells.

Ascospores were obtained from gross cultures or tubes by crushing perithecia or by scraping spores from the side of the tube where they had been shot or by picking out masses of perithecia and spores formed between the sides of the container and the sphagnum. They were transferred directly to ampules or Van Tieghem cells or kept dry in pill boxes for a month or so until needed.

The following numbers of Van Tieghem cells were used in the various experiments:

At 51½° C. 2 V.T. cells were used for each temperature wet and for each temperature dry besides 2 controls.

At 27½°–30° C. 8 V.T. cells were used.

At 10°–12° C. 8 V.T. cells were used.

At 0° C. 4 V.T. cells were used.

At − 37½° C. several V.T. cells were used besides the controls.

At − 79° C. 17 V.T. cells were used for the ascospores besides 5 controls. In these germination failed to occur in 4, 1 a control. 10 V.T. cells were used for conidia besides 2 controls. Germination failed to occur in 3, 1 a control.

At − 170° to − 190° C. 18 V.T. cells were used for ascospores besides 4 controls. 9 V. T. cells were used for conidia besides 4 controls. In these all the wet conidia except the controls failed to germinate but the dry conidia germinated normally.

† Spores were exposed in Van Tieghem cells.

†† Spores were at that temperature from time they were shot from the ascus.

* Time of germination was calculated by comparison of length of mycelium when observed with length of mycelium where period of growth for given development of spore was known.

** "germ." represents germination of an appreciable number of spores, one to ninety-four per cent. The actual percentages are not included here because the periods elapsing between the germination of the first spores and the calculating of the percentage germination for each cell were not comparable.

RESULTS OF EXPERIMENTS ON EFFECT OF TEMPERATURE ON SPORES OF *Neurospora crassa*

Kind of Spore	Temperature ° C. to Which Spores Were Exposed	Time of Exposure	Condition of Spores	Germinated or Not	Time after Exposure to Germination of First Spores
Ascospores	25.5°	Control	Wet	**Germ.	3 hrs. 15 min.
"	51.5°	0 hrs. 1 min.	Wet	**Germ.	3 hrs. 27 min.
"	"	0 hrs. 1 min.	Dry	**Germ.	3 hrs. 27 min.
"	"	1 hr. 20 min.	Wet	**Germ.	*8 hrs. 8 min.
"	"	1 hr. 20 min.	Dry	**Germ.	*7 hrs. 36 min.
"	"	2 hrs. 38 min.	Wet	**Germ.	*6 hrs. 0 min.
"	"	2 hrs. 38 min.	Dry	**Germ.	*6 hrs. 20 min.
"	"	3 hrs. 20 min.	Wet	**Germ.	*18 hrs. 15 min.
"	"	3 hrs. 20 min.	Dry	**Germ.	*5 hrs. 45 min.
"	"	4 hrs. 8 min.	Wet	**Germ.	*17 hrs. 15 min.
"	"	4 hrs. 8 min.	Dry	**Germ.	*4 hrs. 45 min.
Ascospores	27.5°–30°	††	Wet	**Germ.	3 hrs. 0 min.
"	"	††	Wet	**Germ.	4 hrs. 10 min.
Ascospores	†10°–12°	24 hrs. 0 min.	Wet	**Germ.	3 hrs. 30 min.
"	†0°	60 hrs. 15 min.	Wet	**Germ.	2 hrs. 15 min.
"	† "	82 days	Wet	**Germ.	
Ascospores	27.5°	Control	Wet	**Germ.	3 hrs.
"	−37.5°	0 hrs. 13 min.	Wet	**Germ.	3 hrs.
"	"	0 hrs. 45 min.	Wet	**Germ.	3 hrs.
Ascospores	27.5°	Control	Wet	**Germ.	3 hrs.
"	"	"	Wet	Not	
"	−79°	0 hrs. 7 min.	Wet	**Germ.	3 hrs.
"	"	1 hr. 45 min.	Wet	**Germ.	3 hrs.
"	"	1 hr. 0 min.	Wet	Not	
"	"	3 hrs. 0 min.	Wet	Not	
"	"	72 hrs. 0 min.	Wet	Not	
"	"	72 hrs. 0 min.	Wet	**Germ.	3 hrs.
"	"	48 hrs. 0 min.	Wet	**Germ.	3 hrs.

"	"	72 hrs. 0 min.	Wet	**Germ.	3 hrs.
"	"	48 hrs. 0 min.	Wet	**Germ.	3 hrs.

RESULTS OF EXPERIMENTS ON EFFECT OF TEMPERATURE ON SPORES OF *Neurospora crassa*—*Continued*

Kind of Spore	Temperature ° C. to Which Spores Were Exposed	Time of Exposure	Condition of Spores	Germinated or Not	Time after Exposure to Germination of First Spores
Ascospores	27.5°	Control	Wet	**Germ.	3 hrs.
"	"	"	Dry	**Germ.	3 hrs.
"	−170° to −190°	0 hrs. 5 min.	Wet	**Germ.	3 hrs.
"	"	0 hrs. 5 min.	Wet	Not	
"	"	0 hrs. 10 min.	Dry	**Germ.	3 hrs.
"	"	1 hr. 0 min.	Dry	**Germ.	3 hrs.
"	"	1 hr. 0 min.	Wet	**Germ.	3 hrs.
"	"	20 hrs. 0 min.	Wet	**Germ.	3 hrs.
"	"	24 hrs. 0 min.	Dry	**Germ.	3 hrs.
"	"	48 hrs. 0 min.	Dry	**Germ.	3 hrs.
Conidia	−37.5°	0 hrs. 15 min.	Wet	**Germ.	
"	"	1 hr. 0 min.	Dry	**Germ.	
Conidia	27.5°	Control	Wet	**Germ.	
"	"	"	Wet	Not	
"	−79°	0 hrs. 1 min.	Wet	**Germ.	
"	"	1 hr. 0 min.	Wet	**Germ.	
"	"	1 hr. 0 min.	Wet	Not	
"	"	1 hr. 45 min.	Wet	Not	
"	"	3 hrs. 0 min.	Dry	**Germ.	
Conidia	27.5°	Control	Wet	**Germ.	
"	"	"	Dry	**Germ.	
"	−170° to −190°	0 hrs. 5 min.	Wet	Not	
"	"	1 hr. 0 min.	Wet	Not	
"	"	1 hr. 0 min.	Dry	**Germ.	

DISCUSSION

The resistance of these fungi to extremes of temperature presents certain points of interest. The ability of these spores to withstand heat and the frequency of growth following conflagrations have been noted so generally that it has come to be assumed that these fungi, and especially *M. sitophila*, are resistant specifically to heat, or especially adapted to growth at relatively high ranges of temperature.

It seemed of possible interest, therefore, to determine whether this material of the closely allied but less studied species, *N. crassa*, that had developed on charred stubs in Cuba following a rather complete brush burning was in reality a thermophile in its temperature relation with a growth optimum at relatively high ranges of temperature and with germination of ascospores and conidia only after being subjected to extremes of heat higher than the usual summer range, or merely a generally hardy fungus resistant to extremes of low as well as of high temperature as it might be to any other unfavorable condition of its environment. The tests which were made, although not sufficiently controlled to yield results of quantitative significance, did furnish qualitative data of some interest.

In these tests, the resistance of *Neurospora crassa* to extreme cold and other unfavorable conditions as well as to extreme heat and its normal development at a moderate temperature, 27° C., have been demonstrated. Although a tropical species that may encounter extremes of heat, it does not meet the extreme cold, − 80° to − 190° C., which the ascospores and conidia survived without injury in the experiments described here. Nor in the tropics would one find long periods of freezing temperatures or even a temperature as low as 0° C. which the ascospores of *N. crassa* endured without injury frozen in blocks of ice for two months. The ascospores were found even more resistant than the conidia, for they could endure temperatures as low as − 170° to − 190° C. for twenty hours when moist or for forty-eight hours when dry and as high as 50° C. for four hours when moist or dry, although heating to 50° C. for more than an hour retarded germination for from three to fifteen hours. The conidia were only somewhat less resistant, surviving temperatures as low as − 170°

to − 190° C. for an hour when dry and as low as − 80° C. for three hours when moist, although killed at − 170° to − 190° C. when moist within five minutes. A further instance of resistance was found in the growth of ascospores to produce mycelium and conidia without sufficient food or air after cooling to − 79° C.

A consideration of these results shows that this species of the *Monilia* group, *N. crassa*, is a generally resistant fungus that develops normally at a moderate temperature rather than a thermophile with a growth optimum at relatively high ranges of temperature and that this resistance to heat is but one phase of a general hardiness. The outstanding instance of this resistance is the ability of the ascospores to withstand temperatures ranging from − 190° to 50° C. without injury. The association with heat would seem to be incidental to some other factor in the environment especially suitable for the growth of the fungus such as the production or freeing of specific carbohydrates during the heating of the wood or other substratum.

SUMMARY

Material from Colonia Palmarito, Central Trinidad, Santa Clara Province, Cuba, after being kept dried for nearly three years was revived, cultured and studied under laboratory conditions.

The material used for the experiments was taken from one of the gross cultures and from pure cultures on cornmeal agar because these cultures had a scanty fringe of conidiophores, leaving a bare surface where perithecia and bulbils formed. Perithecia or bulbils developed in ten days or two weeks after the conidiophores appeared. Conidiophores formed in the gross cultures from dried material in ten days, or in the pure cultures within twenty-four hours after inoculation. More or less luxuriant growth occurred in the cultures, depending upon the substratum and the amount of moisture present.

The fungus was identified by Dr. B. O. Dodge as *Neurospora crassa* Shear and Dodge. The conidia were somewhat large for the species but measurements of the ascospores, asci and perithecia which are the distinguishing structures correspond with those described for the type.

Formation of bulbils, heterothallism, occurrence of abnormally

large ascospores and germination of ascospores from both ends were again noted for the species. Three points heretofore less emphasized were noted, namely, (1) that ascospores even when unheated germinate in three to four hours, (2) that the *Monilia* stage is positively heliotropic and (3) that the markings on the walls are not "ridges" but lighter differentiated parts of the wall.

The ascospores were found resistant to 50° C. although with delayed germination when moist and heated for more than one hour, to 0° C. for two months when frozen in blocks of ice with no delay in germination when returned to room temperature, to − 170°to−190° C. for twenty hours when wet and for forty-eight hours when dry with no delay in germination. They were readily germinated at room temperature in three hours without previous heating. The conidia were found resistant to − 80° C. for one hour when wet and to − 170° to − 190° C. for one hour when dry, although killed at this temperature in five minutes when wet. Ascospores that had been confined in an ampule for several days after cooling to − 80° C. for an hour or more were found to produce mycelium and spores of two types, normal, small conidia on stunted conidiophores above the water and *Oidium*-like spores below the surface.

It is concluded that *Neurospora crassa* is a generally resistant fungus, not a thermophile requiring heat in its development, but resistant to extreme cold as well as to extreme heat and also to other adverse conditions.

In conclusion, I take this opportunity to thank Professor W. H. Weston for supplying the material and for his help throughout the course of the study, Dr. B. O. Dodge for his kindness in identifying the fungus, reading the manuscript and supplying the slide from which the drawing of the cross section of an ascospore was made, and Professor Theodore Lyman for his aid in supplying the liquid air used in the experiments.

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STEMPHYLIUM CONGESTUM AND ITS RELATION TO DECAY IN APPLES

GEORGE D. RUEHLE

(WITH 2 TEXT FIGURES)

Two species of the genus *Stemphylium* have been described as causing a rot of apples. In 1924, Kidd and Beaumont (**3**) isolated *Stemphylium graminis* (Corda) Bon. from lenticel spots on apples in England, and by means of inoculation experiments proved that this species can be parasitic on apples. In 1928, Newton (**4**) described a new species, *S. congestum* Newton, as causing a decay of apples in the Pacific Northwest. In addition to these two species, several species of *Pleospora* occurring on apple fruit possess a *Stemphylium-Macrosporium* conidial stage (**2**, **3**, **4**). The imperfect stage of these *Pleospora-Stemphylium* species can be readily recognized as distinct from the *Stemphylium* species mentioned above, since when grown on culture media the latter generally produce enormous numbers of conidia in dense botryose clusters, while the former generally produce fewer conidia which are borne singly on the conidiophores. In addition to this difference in conidial formation, the *Pleospora* species readily produce perithecia on culture media, whereas such structures have not been observed in cultures of *S. graminis* or *S. congestum*.

From 1118 isolations from decayed areas on apple fruits from cold storage, the writer isolated twenty-nine cultures of the *S. congestum* type. Most of these cultures were found to be pure in the original isolation plates, but some were mixed with *Pleospora*, *Alternaria*, *Cladosporium*, or *Dematium pullulans*. Pure cultures were obtained by following Keitt's method of single-spore isolation (**1**), and these were grown on various solid culture media, including 2 per cent dextrose potato agar, Difco cornmeal agar, and Difco prune agar. Macroscopically, these cultures appeared to be identical. When examined microscopically, however, two

distinct types were recognized, chiefly on the basis of spore size. A representative culture of each type was saved for further study.

On 2 per cent dextrose potato agar, the colonies develop quite rapidly, attaining a diameter of 75 millimeters in eight days, when grown at 25° C. At first they are a deep olive in color, which gradually changes to an olivaceous black. They are very dense from the first, and the surface assumes a velvety appearance from the copious production of spores.

A culture of *S. graminis* was obtained from the Centraalbureau

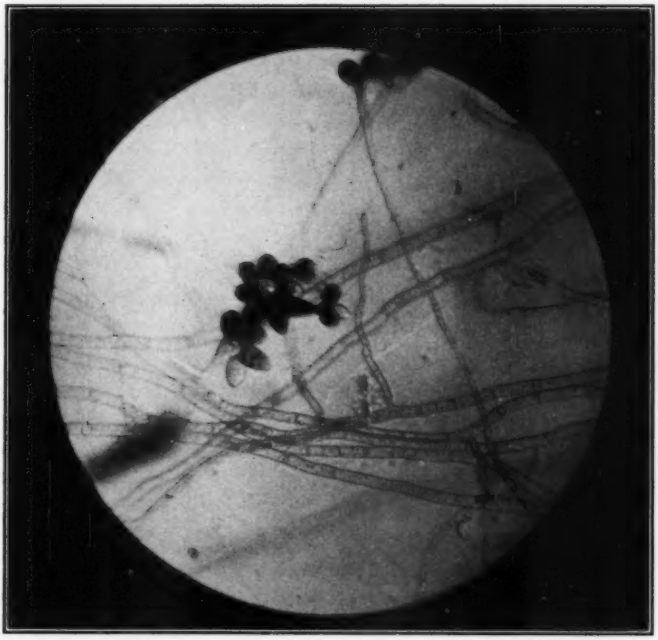

FIG. 1. Photomicrograph of *Stemphylium congestum* var. *minor* growing on Difco cornmeal agar. × 275.

voor Schimmelcultures, and *S. congestum* was available for study from the stock cultures at the Washington Experiment Station. These were compared culturally with the two *Stemphylium* forms isolated by the writer. Of these two, the one having the larger

spores was found to agree in all respects with *S. congestum*. It is believed, however, that Newton did not see all the spore types produced by this species. On certain kinds of culture media, especially the 2 per cent dextrose potato agar and Czapek's

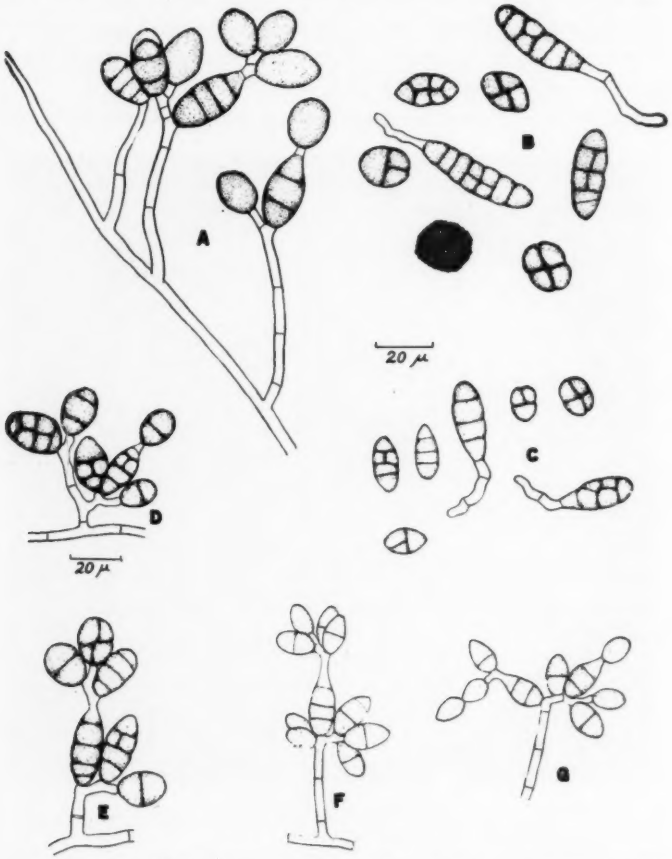

FIG. 2. *Stemphylium* forms from the apple. *A*, *S. congestum* on Czapek's medium; *B*, mature spores of *S. congestum*; *C*, mature spores of *S. congestum* var. *minor*; *D* and *E*, *S. congestum* on dextrose potato agar; *F* and *G*, *S. congestum* var. *minor* on dextrose potato agar. All drawings made with the aid of the camera lucida. *D* and *E* drawn to the scale indicated on the left; the remainder to the scale indicated on the right.

modified synthetic medium, both in the stock cultures of the Experiment Station and in the cultures isolated by the writer, many of the conidia are borne in short chains, with the basal spore in the chain obclavate in shape and resembling an *Alternaria* spore (FIG. 2, *E*). The botryose clusters of sphaero-quadrilateral conidia figured and described by Newton are always present as well, and this type of spore formation is the dominant one for the species. When the *Alternaria*-like spores were first found, they were thought to be the result of a contamination with *Alternaria*, but when single spores of this type were grown, the resulting colonies produced both types of spores in the same manner as the original cultures of the fungus.

The formation of some of the spores in short chains is also a constant characteristic of the smaller-spored type. (FIG. 1 AND FIG. 2, *F*.) This form agrees in all essentials with *S. congestum*, except in the matter of spore size. The conidia of the latter average 26 × 15.5 microns, while the spores of the former average but 16.5 × 10.6 microns. The small-spored type is, therefore, considered to be a variety of *S. congestum* Newton.

On culture media, *S. graminis* appears to be quite distinct from the forms isolated by the writer. The colonies are darker in color, beginning as a grayish-brown rather than olive, and develop somewhat slower. The conidia are rarely produced in chains, and when such chains are found, they consist of but two spores. The long pluri-septate conidia of the *Alternaria* type were not observed in this species.

STEMPHYLIUM CONGESTUM

In Newton's description of this species, the following characteristics for the fungus are given (**4**):

"Hyphae variously branched, septate, dark, making a dense growth on various media with very copious production of conidia; conidia muriform, sphaero-quadrilateral to ovate-oblong, 1 to 3 transverse septa, 1 longitudinal septum or none, smooth when young, but tuberculate with age, and becoming nearly black, 17–30 × 12–19 microns, average 23.5 × 15.5 microns; conidia produced acrogenously on simple or slightly branched septate conidiophores, never single but accumulating in botryose clusters of two to many."

As a result of the cultural studies of the species by the writer, this description should be emended as follows:

Hyphae variously branched, septate, at first hyaline, then becoming light brown and finally dark brown, making a dense growth on various media with very copious production of conidia: conidia muriform, mostly sphaero-quadrilateral to ovate-oblong, one to three transverse septa, one longitudinal septum or none, many obclavate, frequently beaked, with three to six cross septa, one or two longitudinal septa or none, frequently constricted at the septa; conidia smooth and lightly colored at first, but usually tuberculate with age and becoming nearly black, 17–40 × 9–24 microns, average 26.5 × 15.5 microns; conidia produced acrogenously on simple or slightly branched, septate, light brown conidiophores, accumulating in botryose clusters of two to many, or in short chains of two to three, frequently the basal spore of the chains *Alternaria*-like and forming a cluster of smaller spores on a short beak.

Stemphylium congestum Newton var. **minor** nov. var.

As in the species with the following exceptions: Conidia mostly ovate-oblong to obclavate, some sphaero-quadrilateral, one to four transverse septa, one or longitudinal septa or none, usually constricted at the septa; conidia smooth, lightly colored at first, becoming dark brown, 12–31 × 7–13 microns, average 16.5 × 10.6 microns.

Isolated from dark brown lesions on Jonathan apples, and by means of inoculation experiments found capable of producing such lesions on ripe apples. Of less frequent occurrence than the species.

Inoculation experiments were carried out with both *S. congestum* and the variety, on ripe Jonathan and Rome Beauty apples, at 25° C., 15–25° C., and 0° C., using the method recently described by Huber (**5**). At the higher temperatures, rot lesions formed rather slowly when inoculations were made by placing spores in fresh punctures. At 25° C., *S. congestum* produced rotted areas up to 55 millimeters in diameter after a 60-day incubation period. At 15–20° C., lesions 20–30 millimeters in diameter were produced in the same length of time. At 0° C., rotting

was very feeble, since after four months' incubation at this temperature the largest lesions produced were slightly less than 15 millimeters in diameter. The variety produced decay at about the same rate as the species.

The rotted areas produced by *Stemphylium* are quite firm, light to dark brown in color, and are slightly wrinkled and sunken on the surface. Numerous spores may be produced in the rotted tissues, but none appear on the surface of the lesions. The mycelium of the fungus is both inter- and intra-cellular.

Stemphylium is of little importance on apples when they are held at cold-storage temperatures. Under common storage conditions, however, the rot may be of considerable importance on ripe apples. Lesions produced by *Stemphylium* may readily be mistaken for lesions produced by several species or strains of *Alternaria*, and no doubt a large percentage of decay in the Pacific Northwest attributed to *Alternaria* spp. is due to *S. congestum*.

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FOMES EVERHARTII ASSOCIATED WITH THE PRODUCTION OF STERILE RIMOSE BODIES ON FAGUS GRANDIFOLIA

RAY R. HIRT

(WITH PLATE 25)

Sterile rimose conks are often found on beech and birch and their production is commonly associated with *Fomes igniarius* Gill. It is not unusual to find normal fruiting bodies of this fungus and sterile rimose bodies on the same host. The decay accompanying such sterile bodies is typical of the white heartrot produced by *Fomes igniarius*.

On August 20, 1929, a beech (*Fagus grandifolia* Ehrh.) was observed which had upon it a large number of sterile rimose conks. This tree was approximately 75 years of age and was growing in the Pack Demonstration Forest at Warrensburg, New York. The sterile bodies were similar in appearance to those supposedly produced by *Fomes igniarius*. From one of the larger sterile conks a normal sporophore had developed and at the time it was casting spores in abundance. Upon examination it was discovered that the fruiting body was not that of *Fomes igniarius*, but was typical of *Fomes Everhartii* Ellis & Gall. This identification was later verified by Dr. L. O. Overholts.

The rot produced in the host was similar to that produced by *Fomes igniarius* except, possibly, that there were fewer black lines of decay than are generally found in the white heartrot associated with that fungus.

Fomes Everhartii Ellis & Gall. is not common in the Adirondacks and, so far as the author is aware, has never before been reported as associated with the production of sterile rimose conks on beech.

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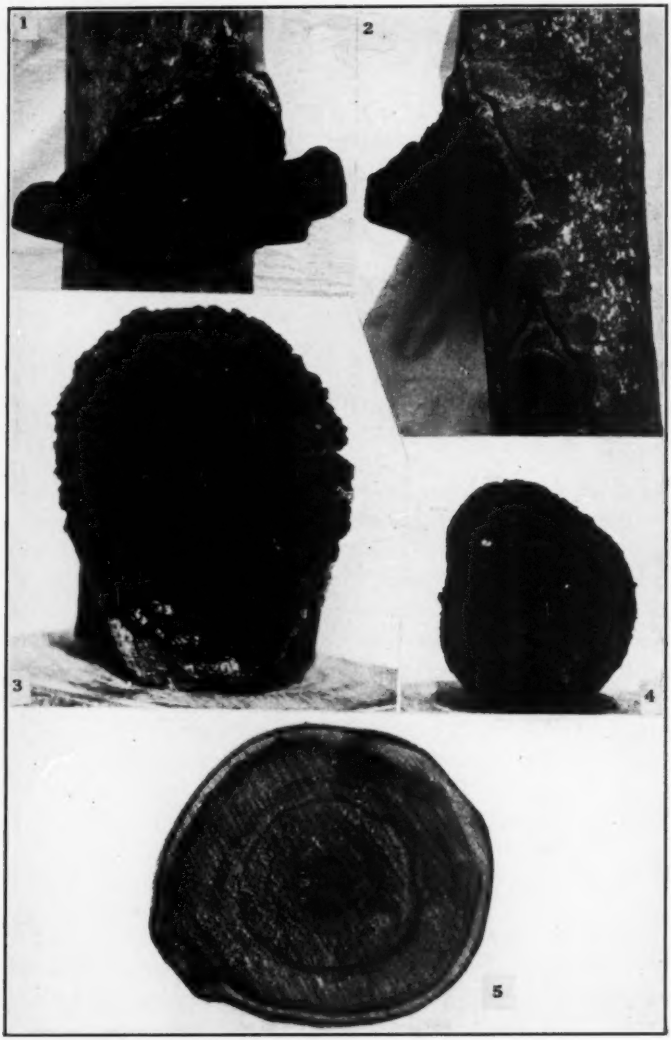

FOMES EVERHARTII

EXPLANATION OF PLATE 25

Figures 1 and 2. Two views of a sporophore of *Fomes Everhartii* which show it to be growing directly out of a sterile rimose conk. × 1/7; Figure 3. One of the larger, well developed sterile bodies. × 5/12; Figure 4. A younger sterile body than that shown in Figure 3. × 3/8; Figure 5. A cross section of the decayed trunk of the host to show the general appearance of the rot. × 3/10.

THE STRUCTURE OF THE PERITHECIUM IN THE MELIOLINEAE

MILDRED E. RAGLE

The Meliolineae comprises a homogeneous group but shows relationships with several groups of fungi. Its members are remarkably constant as to spore character but to a less degree regarding the structure of the perithecium.

The Meliolineae show relationship with the Microthyriaceae through *Amazonia*. The original description of *Amazonia* places it as a section of the Microthyriaceae. von Höhnel has shown that in this genus, under the shield-like cover, a completely closed perithecium exists, pale and thin walled, and properly regards this as a transition genus between *Meliola* and the Microthyriaceae. Superficially there is a striking resemblance between *Amazonia* and *Asterina*. Both possess hyphopodiate mycelium, and the perithecium in each case is rounded above. However, *Asterina* has a large stellate ostiole and the perithecium is flattened, while the ostiole in the Meliolineae, when present, is small and circular, and the perithecium varies from dimidiate to globose, but is never flat.

The relationship of the Meliolineae with the Dothideales is shown through the genus *Actinodothis*. However, as a rule, the Dothideales are partially, if not entirely, immersed in the substratum, while *Actinodothis* is entirely superficial with the exception of a few minute strands which anchor the perithecium to the substratum. The asci in *Actinodothis* are evanescent, disappearing soon after the spores are mature. This is a constant characteristic of the Meliolineae.

The Meliolineae in itself is a homogeneous group. The spores show very little variation in size and shape.

To determine whether the closely related genera showed any constant differences in perithecial structure, microtome sections of numerous species were studied using one or more species of each genus and, in the case of *Meliola*, one member of each subgroup. The following species were examined.

Actinodothis Perrottetiae; Amazonia Perrottetiae; Amazonia anacardiacearum; Amazonia Acalyphae; Amazonia ohianus; Amazonia asterinoides; Amazonia Clusiae; Irene tonkinensis; Irene inermis; Irenopsis scaevolicola; Irenina longipoda; Meliolina Sydowiana; Meliola nidulans, group 1; *Meliola contorta*, group 2; *Meliola Piperis*, group 3; *Meliola Paulliniae*, group 4; *Meliola bicornis*, group 4; *Meliola variaseta*, group 5; *Meliola Wardii*, group 6; *Meliola Sideroxili*, group 7; *Meliola malacotricha*, group 8; *Meliola Lisanthi*, group 9; *Meliola Byrsonimae*, group 10; *Meliola Psidii*, group 11.

This investigation showed that in all cases the perithecium is composed of two types of cells. The outer part consists of large, biscuit-shaped to oblong cells with heavy cell walls. These cells are always colored, ranging from brown to black, being in all cases the same color as the mycelium. The cells are remarkably uniform in size throughout the group, ranging from 7 to 10 microns in diameter regardless of the size of the perithecium on which they are found. In the genus *Meliola*, the outer cells are one row thick. One exception was observed in which, however, only two or three places were observed in one perithecium where there were double rows. In *Amazonia*, the cells are arranged in two or three to many rows. *Actinodothis* shows many rows of cells, the outermost being arranged to form a stroma. In *Irene*, *Irenina* and *Irenopsis*, this tissue is one cell thick.

The inner layer is more delicate and lighter colored. It forms a smooth lining for the perithecium and is even more constant in character for the group than is the outer layer. In *Actinodothis*, which has the typically dimidiate perithecium, this layer is the only one between the asci and the substratum. A similar condition is found in *Meliola malacotricha* and *Irenopsis scaevolicola*. In some cases a differential staining was obtained in the two layers; the outer one invariably showing a reaction similar to that of the mature spores and the lignified tissues of the host with Pianeze III B, while the inner one often took a stain similar to the young spores and the contents of the perithecium. The cells of this layer are long and narrow with tapering end walls. In size, they are approximately 1.5 to 3 by 8 microns. This layer is usually one cell thick, the only exception being in *Amazonia*, where it is found to be two cells thick in some species.

Externally, the shape of the perithecium varies from the dimidiate, elongate, dothid-like structure found in *Actinodothis*, through the typically dimidiate forms in *Amazonia* (of which the highest, *A. asterinoides*, at maturity shows a globose perithecium) to the spherical perithecium of *Meliola*.

In the genera of the Meliolineae, a well defined base may be absent as in *Actinodothis Perrottetiae*, *Irenopsis scaevolicola* and *Meliola malacotricha*, where the inner layer of the perithecium rests directly on the substratum, or it may be represented by the outer layer of the perithecium as in *Meliola bicornis* and *Meliola nidulans*. The base is generally present in *Amazonia*, *Irene*, and some of the species of *Meliola*, where it is represented by a mass of mycelium, or a stalk of cells resembling those in the outer layer of the perithecium, or by a flat disk from which setae radiate. In *Meliolina*, the base takes the form of a slender stipe.

There is variation in the surface cells in the outer layer of the perithecial wall. In *Meliola nidulans* the surface is even, while in *Meliola Psidii* the cells show a very few irregularities. *Meliola bicornis*, *Meliola contorta*, and *Meliola Wardii* show a distinct wartiness. Warty protuberances present the most common type of surface structure in the group. These may be so prominent as to become vermiform appendages, as found in *Irene*, or still longer, as the perithecial setae of *Irenopsis*, where they are most common. Perithecial setae have been reported on *Meliola contorta*, but none were found in the material examined. Perithecial setae are never found in *Irenina*.

An ostiole may or may not be present. When it is present, it is usually small but well defined. The cells of the perithecium form a short crown-like beak, which surrounds the opening. In some species, the inner layer of the perithecium extends up into the ostiole and forms a lining for it. In the majority of the species observed, in which the ostiole was present, the crown-like beak was a continuation of the outer layer of the perithecium.

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SEPTATION OF THE ASCUS IN DOTHIDINA

RHODA B. CROUCH

A peculiar condition of septation of the ascus of *Dothidina costaricensis* Stevens was reported by F. L. Stevens in 1927.[1] This septation occurs either longitudinally or transversely. The phenomenon of septation of the ascus is very rare, occurring, so far as is known, in only a few other fungi which are widely separated taxonomically. The condition has been reported in the genera *Otthiella*,[1] *Ascobolus*,[2] *Sphaerophoron*,[3] *Acroscyphus*,[3] *Lichina*[3] and *Paulia*.[3] According to the usual way in which spores are delimited from the ascoplasm following the ordinary mitotic division this phenomenon seems to be unexplainable.

With the hope of throwing further light upon this condition sections of *Dothidina costaricensis* Stevens were cut ten microns thick, stained with Pianese III B. The perithecia were also cracked open, the asci mounted in water; septation was found to be present in practically all the asci. The young, immature asci were septate as well as the mature asci. A few asci showed no septation but this was probably due to mechanical crushing. This study did not point out how these septations arose, for in the asci examined the septation was complete when examined; however it did seem to be due to an extension of the cell wall between the spores giving rise to chambers, each of which contained one spore or on rare occasions two.

A thorough examination of all available species of *Dothidina* and related genera was carried out to ascertain whether any of these allied genera exhibited the same phenomenon. This was done by cracking the perithecia open and mounting in water. Following is a list of the genera and species examined:

Bagnisiopsis peribebuyensis (Speg.) Theiss. & Sydow; *Amerodothis guianensis* Stevens; *Auerswaldia chamaeropsis* (Cooke) Sacc.; *Auerswaldia cecropiae* P. Henn.; *Auerswaldia* species; *Auerswaldia Pringlei* (Peck.) Sacc.; *Dothidina costaricensis* Stevens; *Dothidina palmicola* (Speg.) Theiss. & Sydow; *Dothidina*

scabrosa Sydow; *Dothidina discoformis* (Wint.) Theiss. & Sydow; *Dothidina Fiebrigii* (P. Henn.) Theiss. & Sydow; *Dothidina amadelpha* Sydow; *Uleodothis Pteridis* Stevens; *Uleodothis Paspali* Stevens; *Dothidella flava* Stevens; *Dothidella betulina* (Fries) Sacc.; *Dothidella portoricensis* Stevens; *Systremma Pterocarpi* Doidge; *Achorella guianensis* Stevens; *Achorella costaricensis* Stevens; *Achorella Attaleae* Stevens; *Dothidea graminis* Peck.

In none of the above forms except *Dothidina costaricensis* Stevens was ascus septation found to occur. The origin and function of this septation could not be ascertained due to the absence of living, young material.

Though negative these results appear to be worthy of record.

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A STUDY OF SOME HOMOTHALLIC AND HETEROTHALLIC ASCOMYCETES [1]

LAWRENCE M. AMES

The discovery of homothallism and heterothallism in the Mucorales by Blakeslee (**2**), in the Eubasidiomycetes by Kniep (**8**), Mlle. Bensaude (**1**), and others, in the Rusts by Craigie (**3**), in the Smuts by Hanna (**6**), and others, and in the Ascomycetes by Dodge (**4**), Edgerton (**5**), etc., has led the writer to undertake further studies in the Ascomycetes.

This paper presents some work that has been done on a few coprophilous Ascomycetes. Single spore cultures were made in all cases and matings in all combinations were employed in the study of the sexuality of these fungi. The cultures were all grown on agar in petri dishes at room temperature. Single spore cultures were obtained by a dry needle method similar to that described by Hanna (**7**).

It was found helpful in germinating the spores of *Ascobolus* to treat them first with a warm solution of dilute HCl for five or ten minutes and after planting to heat them in an oven to a temperature of 78° C. for an interval of 25 minutes. In the case of *A. immersus* even this treatment failed in all but two cases.

The following table gives in a brief form the origin and conditions under which each organism was grown and the type of fruiting, *i.e.* whether homothallic or heterothallic.

The work of Marchal (**9**) on *Chaetomium elatum* Kunze & Schm. and *Hypocopra fimicola* Sacc. (*Fimetaria fimicola* (Roberge) Griffiths & Seaver) is substantiated by the present work.

In his study of *Neurospora* Dodge (**4**) found an interesting phase of spore formation in the species *N. tetrasperma*. The ascus in this species normally contains four spores. If several perithecia are crushed in which spores are maturing there will be found occasional asci with an abnormal number of spores such as three

[1] This paper is a much abbreviated form of a thesis submitted in partial fulfillment of the requirements for the M.S. degree at Michigan State College.

Name of Organism	Origin	Culture Media	Spores per Ascus	Condition of Sexuality
Chaetomium spirale Zopf.[1]	Straw	P. d. agar [6]	8	Homothallic
C. globosum Kunze [2]	Straw	P. d. agar	8	Homothallic
C. elatum Kunze & Schmidt	Straw	P. d. agar	8	Homothallic
C. funicola Cooke	Straw	P. d. agar	8	Homothallic
C. aureum Chivers [3]	Rice hulls	P. d. agar	8	Homothallic
C. trilaterale Chivers [4]	Blueberry roots	P. d. agar	8	Homothallic
C. cochliodes Pallister	Straw	P. d. agar	8	Homothallic
C. angustum Chivers	Straw	P. d. agar	8	Homothallic
C. aterrimum Ellis & Ev.	Straw	P. d. agar	8	Homothallic
C. murorum Corda	Horse dung	Dung agar	8	Homothallic
Fimetaria fimicola (Roberge) Griff. & Seaver	Horse dung	Dung agar	8	Homothallic
Pleurage arizonensis D. Griff.	Horse dung	Dung agar	4	Homothallic
P. anomala D. Griff.	Horse dung	Dung agar	4	Homothallic
P. anserina (Ces.) Kuntze	Horse dung	Dung agar	4	Homothallic
P. decipiens (Wint.) Kuntze	Horse dung	Dung agar	8	Homothallic
P. minuta (Fuckel) Kuntze	Horse dung	Dung agar	8	Homothallic
Ascobolus stercorarius (Bull.) Schröt.[5]	Horse dung	Dung agar	8	Hetero-homothallic

[1] Three additional unidentified species of *Chaetomium* were found to be homothallic.
[2] This species was given to me by Mr. F. C. Strong of Michigan State College, who found it on some straw which came from Maryland.
[3] *Chaetomium aureum* was sent to me by Dr. Edgar C. Tullis of the University of Arkansas.
[4] Mr. Stanley Johnston of South Haven, Michigan, kindly sent this fungus.
[5] *Ascobolus immersus* gave no results as to its sexuality, but brought to light an interesting food requirement necessary for its culture.
[6] P. d. agar—potato dextrose agar.

large and two small spores, or even in extreme cases only one giant spore. Shear and Dodge (**11**) found that monosporous mycelia from these small spores bore only sclerotia or bodies which resembled aborted perithecia. By properly mating these cultures normal perithecia are formed containing asci which normally have only four spores. The larger normal spores have two nuclei when first delimited and thus contain nuclei of both sexes. In *N. sitophila*, which has eight ascospores, four of these spores variously arranged in the ascus are of one sex and the other four of the other sex, this species being invariably heterothallic. One might conceive from the above data that in a genus which contains both four- and eight-spored species he would find them to be homothallic and heterothallic respectively.

In the present work it was found that both the four- and eight-spored species of the genus *Pleurage* were homothallic. It is therefore clear that in a genus in which the number of spores varies with the species no prediction can be made that one of the species will be homothallic and the other heterothallic.

In the genus *Glomerella*, Edgerton (**5**) found a condition which approaches heterothallism. The peculiar trait of producing abundant perithecia at one time and a scarcity at another time in nature gave grounds for presupposing sexual differentiation. Single spore isolations yielded two strains, a "plus" strain of floccose growth and abundant aërial mycelium, and a "minus" strain with scarcely any aërial mycelium. However, single spore cultures of each strain produced abundant perithecia. When both strains were grown on one agar plate there appeared a great mass of perithecia along the line where the mycelia of the two colonies met. To determine whether this was truly sexual stimulation or due to chemical and food relations, some of the perithecia along the border were crushed and separate asci were removed and planted individually on agar plates. Edgerton found that segregation took place giving the two characteristic strains. This segregation of strains gives proof that there was sexual stimulation and therefore sexual differentiation.

A similar condition was found in the present work with *Ascobolus stercorarius*. Single spore cultures of this species gave rise to a few apothecia. By mating single spore cultures it was

found that approximately fifty per cent of the matings stimulated a great abundance of apothecia along the line where the mycelia of the two strains met. This shows that whereas single spore cultures may produce a few apothecia there is, however, a definite sexual differentiation. It is yet to be discovered whether the antherids are functional in all cases or whether parthenogamy may occur to explain the production of the occasional apothecia on single spore cultures.

Difficulty was encountered in germinating the spores of *Ascobolus immersus*, and the two spores which grew produced very weak mycelia and no fruit bodies. This difficulty was also met by Ramlow (**10**) who found that *A. immersus* would not grow or produced only a weak mycelium and almost never the fruit bodies on dung agar alone, but after adding a portion of filter paper to the media he found that the fungus grew and fruited well. In his studies of *A. immersus* both morphologically and cytologically, he demonstrated that this species is parthenogamic (*i.e.* there is no distinct antherid and the paired nuclei in the ascogonial cells and ascogenous hyphae are all of ascogonial origin). Such a species would necessarily be homothallic unless antherids are formed when two sexes of mycelium are present, and no antherids if only one is present.

A number of other Ascomycetes were also studied, one of which proved to be strictly heterothallic, but owing to uncertainty as to their identity they cannot be reported on at present.

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NOTES AND BRIEF ARTICLES

Dr. C. S. Parker of Howard University, Washington, D. C., recently spent a few days at The New York Botanical Garden looking over collections of fungi.

The Editor is finding much difficulty in taking care of the manuscript which is sent in for publication in MYCOLOGIA. In order to save space contributors are hereby requested to cut down their papers as short as possible. This with the increased pagination in MYCOLOGIA will help us to solve the difficulty.

Mr. Paul F. Shope, Mycologist in the University of Colorado at Boulder, spent a few days in September at The New York Botanical Garden looking over Colorado polypores. Mr. Shope is on leave of absence from the University of Colorado and will spend the year in graduate study at the Missouri Botanical Garden, St. Louis, Missouri.

A second edition of "Fungous Diseases of Plants in Agriculture, Horticulture, and Forestry" by Dr. Jakob Eriksson of Stockholm, Sweden, translated from the German by Dr. William Goodwin of London was issued during 1930. The work consists of 526 pages of text and is illustrated with 399 figures, and consists of a review of the principal fungous diseases of northern and middle Europe with the best known methods of control. The book, which is published by Bailliere, Tindall & Cox of London, is attractively printed and illustrated and should find its way into the library of every plant pathologist.

Mycologists and Plant Pathologists will be pleased to see the volume on "The Lower Fungi" by Harry Morton Fitzpatrick, Professor of Mycology, Department of Plant Pathology, Cornell University, Ithaca, New York, which was recently issued. In

this work Dr. Fitzpatrick has given a general treatment of the morphology of the Phycomycetes with keys to the recognized genera. The volume consists of 331 pages illustrated with 112 text figures mostly line drawings bringing out the striking characters of the various genera. The book is published by McGraw-Hill Book Company, Inc., 370 Seventh Avenue, New York. The price is $4.00. It is expected that a more extended review of this book may appear later in MYCOLOGIA.

"The Spore Ornamentation of the Russulas" by Richard Crawshay has just been issued, the work having been published by Bailliere, Tindall & Cox of London, England. Too little attention has been given to spore ornamentation as a means of identifying species in the Basidiomycetes, probably much less than in the Ascomycetes. Perhaps this is because there is less variety in spore-sculpturing in the Basidiomycetes. Mr. Crawshay has made a thorough study of this character in the genus *Russula*. In all seventy species and twenty-two varieties are treated. The spores of eighty-five of these are represented by drawings. The book consists of 179 pages of text and 46 plates. The plates contain the drawings of the spores of the various species of the genus made to a common scale. This excellent work should be exceedingly helpful to those interested in the study of this genus, and an incentive to mycologists to make a similar study of other genera.

INDEX TO VOLUME XXII

New names and the final members of new combinations are in **bold face type.** Mistakes in the spelling of scientific names encountered in text are corrected in the index.